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THESIS

CONVECTIVE HEAT TRANSFER FROM A CYLINDER IN A STRONG ACOUSTIC FIELD

by

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December, 1995

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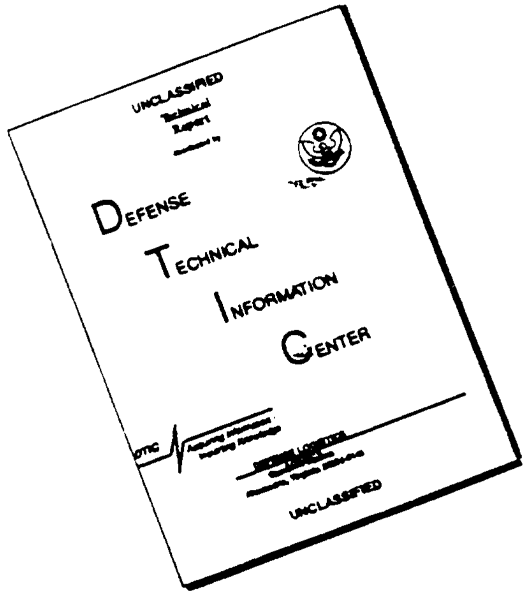

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CONVECTIVE HEAT TRANSFER FROM A CYLINDER IN A STRONG ACOUSTIC FIELD

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LIST OF SYMBOLS, ACRONYMS AND/OR ABBREVIATIONS

a	test cylinder radius [m]
A	amplitude of particle oscillation [m]
B	aspect ratio
c	speed of sound [m/s]
d	diameter of test cylinder [m]
D	diameter of sound chamber [m]
f	frequency [Hz]
Gr	Grashoff number
h	convective heat transfer coefficient [W/m^{2}-K]
I	current [Amps]
k	thermal conductivity [W/m-K]
KC	Keulegan-Carpenter number
l	length of test cylinder [m]
L	distance from test cylinder to termination end plate [m]
M	Mach number
Nu	Nusselt number
P	power [W]
P_m	mean ambient pressure [Pa]
P_0	pressure level [Pa]
P_{ref}	reference pressure [Pa]
PR	pressure ratio
R	gas constant [J/kg-K]
R_{eq}	equivalent thermal resistance [K/W]
R_s	streaming Reynolds number
S	pressure transducer sensitivity [mV/Pa]
SPL	sound pressure level [dB]
T_a	ambient temperature [K]
T_c	center temperature [K]
T_s	surface temperature [K]
U_0	particle velocity [m/s]
V_0	voltage [Volts]
Z	aspect ratio
β	amplitude ratio
γ	polytropic coefficient
δ	Stoke's boundary layer [m]
ε	amplitude parameter
λ	wavelength [m]
Λ	frequency parameter
ν	kinematic viscosity [m^{2}/s]
χ	cylinder length scale
ω	radian frequency [rad/s]

I. INTRODUCTION

The science of convective heat transfer in an acoustic field, while still in its infancy, presents many new and exciting possibilities for application in the future. Different experiments and theory have proven that under the correct circumstances there are certain desirable heat transfer characteristics affecting an object which is immersed in a strong acoustic field. A complete analysis concerning the processes and effects of the related heat transfer phenomena, though, is lacking and desperately needed.

Although thermoacoustics have already been applied to some advanced heat transfer designs, for instance, the thermoacoustic space refrigerator and other thermoacoustic cryocoolers developed at the Naval Postgraduate School, there has yet to be developed anything that can compete on an economic level with what is currently marketed today. The efficiencies obtained so far have been quite low, requiring nearly twice the power of a conventional vapor compression refrigerator. When the fundamentals behind the thermoacoustic phenomenon and the related heat transfer characteristics are completely understood, breakthroughs can occur which could allow industry to move ahead and apply these techniques on an every day basis toward a variety of common uses.

To properly model and control the parameters which impact upon the heat transfer behavior in a thermoacoustic engine, it would be advantageous if the various flow regimes (e.g., turbulent vs. laminar) in the engine could be isolated and analyzed in detail. Further information in this regard may be obtained through a parametric analysis of a suitable model problem by which a measure of the importance (or rather a magnitude of the effect each parameter has on the process as a whole) can be determined. This is an important element of the modeling process and requires study since by understanding the impact that each individual parameter makes upon the thermoacoustic process as a whole, it may be possible to predict the changes in the heat transfer characteristics as individual components are varied.

The work contained within provides an experimental study of some of the dominant heat transfer properties of a particular model problem that may be encountered in thermoacoustic engines. The model problem chosen is one of convective heat transfer from

a cylinder in a zero-mean oscillatory flow. The flow is representative of the acoustic standing wave in a thermoacoustic engine whereas the cylinder represents a tube or other component that may be present in such an engine.

The work involves a correlation of experimental heat transfer data in terms of a suitable Nusselt number (Nu) with other appropriate dimensionless parameters in the problem, such as the streaming Reynolds number (R_s), which itself is a function of length scales, pressure ratios and frequency parameters and, of course, of the Prandtl number (Pr). Through use of high power standing resonant acoustic waves in a cylindrical chamber, a high-intensity internal oscillatory flow is established. Under these conditions, the heat removal rate from a thin cylindrical heating element immersed in the acoustic signal will supply data necessary to arrive at some basic conclusions as to heat transfer phenomena occurring around a cylinder. This work focuses upon two different flow regimes; one in which laminar, attached flow around the cylinder at large values of the streaming Reynolds number is present, and the second in which vortex shedding and other instabilities in the flow are expected to occur at the cylinder surface. The resultant experimental data additionally provides guidelines for determining when the flow transitions from one regime to the other.

II. BACKGROUND

A. HISTORICAL

It has long been understood that a large temperature gradient along the length of a cylindrical tube can, under certain suitable circumstances, spontaneously excite the fluid into oscillations strong enough to create audible sound. Glass blowers provided the earliest accounts of this acoustic effect. They found that when one end of a glass tube was placed in a furnace, the temperature difference between the end of the tube in the furnace and the end still under ambient conditions created an audible tone which was emitted from the open end of the tube. Even though early scientists knew of this effect, it was merely considered to be more of an oddity than a scientific discovery which might have useful implications. In fact, the earliest accounting of what may have been the first ever thermoacoustic engine, the Sondhauss tube (Figure 1), was described by Sondhauss (1850) himself as the "glowing glass harmonica". Lord Rayleigh (1945) gave the first good qualitative analysis of the Sondhauss tube in 1896 in which he described the mechanism behind the effect and posed the theory that mechanical work could be obtained from the vibrations, or oscillations, which were being created by the temperature gradient along the tube.

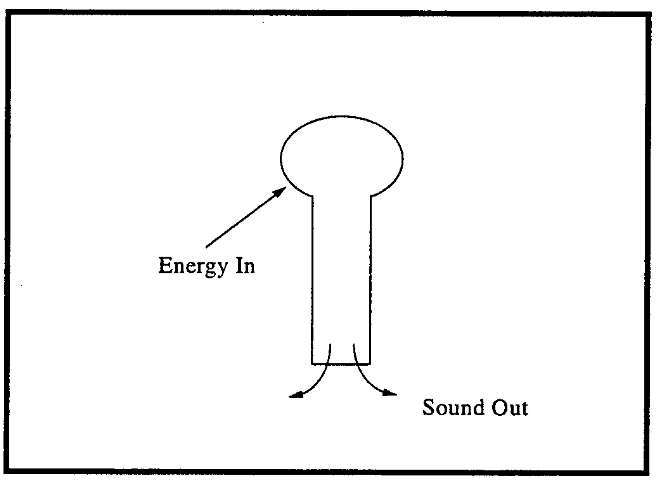

Figure 1. Sondhauss Tube

An extension of research into Sondhauss tubes was conducted by Carter (1988) and included placing a stack of plates at an appropriate point in the tube. The plates included hot heat exchanger strips at one end and cold heat exchanger strips at the other. These improved the effect of the Sondhauss tube, and inspired another scientist, Feldman (1966) to conduct similar research which consequently resulted in an oscillator which produced 27 W of acoustic power from 600 W of thermal power. All of this occurred in the 1960s.

It wasn't until much later that it was postulated that the effect could somehow be reversed, i.e., a temperature gradient could be created along a tube using a powerful, resonating acoustic signal as the driving force. It is only more recently that advances in acoustic technology have allowed serious research toward this goal.

B. RECENT WORK

The heat transfer effect related to this thermoacoustic phenomenon has since been used in the creation of heat pumps and has been explored by several scientists. The results of these attempts include what was termed a pulse-tube refrigerator as developed by Gifford and Longsworth (1966). This refrigerator utilized low frequency, high amplitude oscillations to excite the gas in a tube and create a cooling effect along the surface. The invention of "modern" thermoacoustic refrigeration occurred in the early 1980s at Los Alamos National Laboratory. It was in essence a modification to the work that Carter did, using stacks of plates with a much smaller temperature gradient. Additional engineering developments by others, such as the work at the Naval Postgraduate School with a thermoacoustic refrigerator intended for use on the space shuttle, led to increases in efficiency, as well as to an increase in commercial interest and development. Currently, there are major projects ongoing in several countries as outlined by Swift (1995), including a prototype food refrigerator based upon the Naval Postgraduate School's work being built in the Republic of South Africa. The Ford Motor Company has developed its own version of a thermoacoustic refrigerator while the Tektronix Corporation is working towards a pulse-tube type of refrigerator to be used for cooling electronics to cryogenic temperatures.

All of these attempts are especially significant given the current stigma surrounding the environmentally hazardous use of CFC's. Even though thermoacoustic refrigeration is

still not as efficient as that of current energy efficient vapor compression models, there is a growing demand for something to take their place. By advancing our knowledge-base in this area, and further incorporating a new understanding of how increases to the efficiency of thermoacoustic designs can be made, that it may well be possible that a new thermoacoustic revolution is in our future.

C. THERMOACOUSTIC PROCESS

The basic process behind a thermoacoustic engine can be best described by the model in Figure 2. The upper portion of the figure shows a sound chamber with an acoustic driver at the left end which is used to create a resonant, standing wave in the chamber. At an appropriate point within the chamber, a thermoacoustic stack (Figure 3) is placed with a heat exchanger (Figure 4) on either side of it. The flow of heat is from right to left in the figure. The process of heat transport across the plate is illustrated in the lower portion of the figure. The fluid within the chamber will oscillate due to the acoustic wave, traveling from a point of low pressure to one of high pressure, gaining and losing energy during each half cycle.

For instance, a parcel of gas at temperature T_0 at low pressure moves along line 1, increasing in pressure and temperature until it reaches T++ (has gained two units of heat). At that point, it loses one unit of heat to the plate, thereby reducing its temperature to T+. As the parcel of gas continues through the second half of the oscillatory cycle, it decreases in pressure, and it loses two unit of heat, dropping to T-. It is then able to retrieve a single unit of heat from either the plate at the right hand side of the cycle, or from a heat exchanger at that end. In effect, a "bucket-brigade" of little parcels of gas is formed as the heat transport mechanism. It is the heat exchangers on either end of the thermoacoustic stack and the heat transport mechanisms involved with them that this experiment intends to analyze.

D. HEAT TRANSFER IN ACOUSTIC FIELDS

The early 1950's saw an increased interest towards understanding the heat transfer behavior in oscillatory flows and an earnest effort towards understanding the possible benefits thereof began. Richardson (1967) produced the first significant contribution to this field by providing a coherent and detailed account on the general nature of heat transfer in oscillatory flows. He gave concise documentation on how sound and vibration fields had

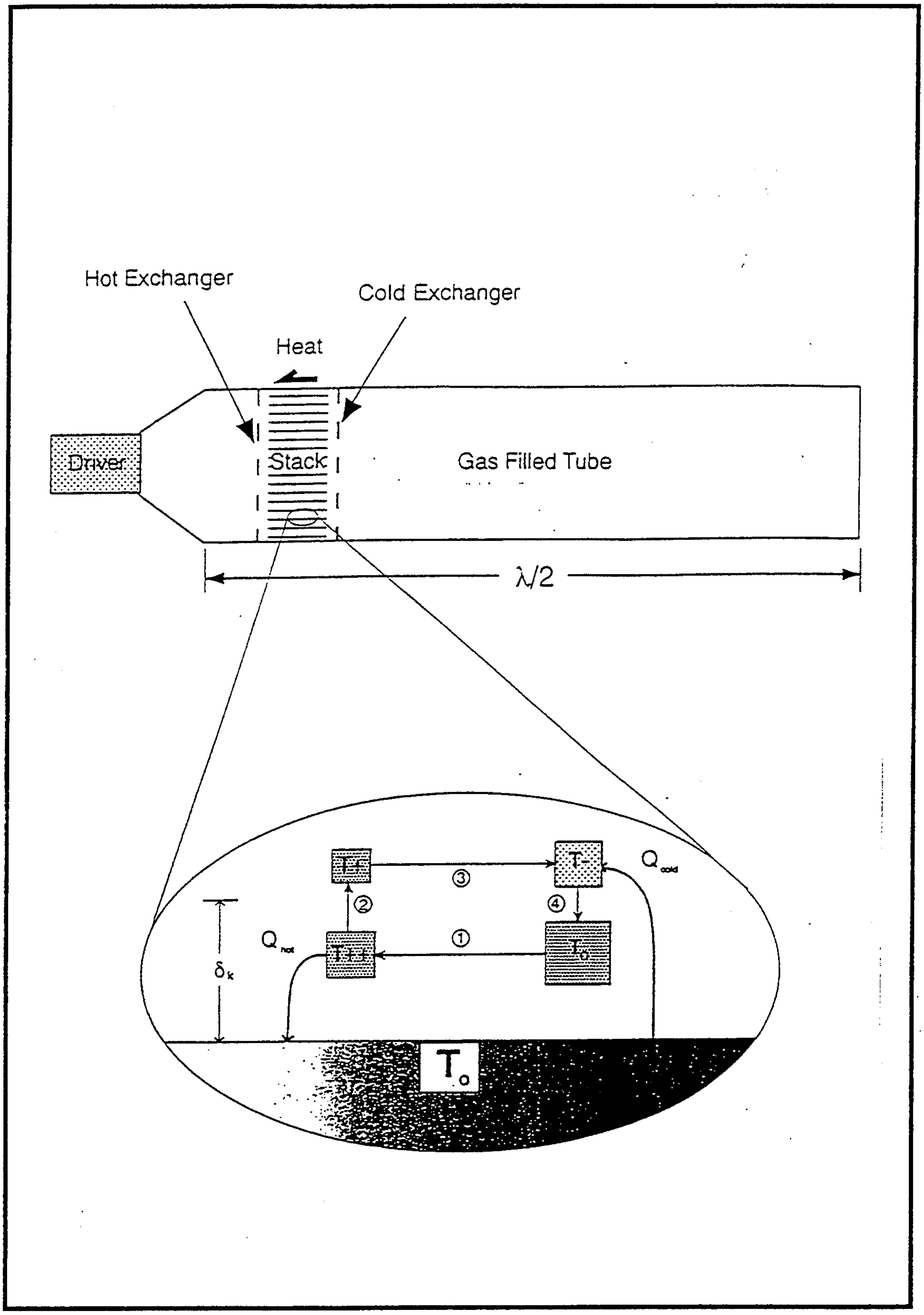

Figure 2. Basic Thermoacoustic Process.

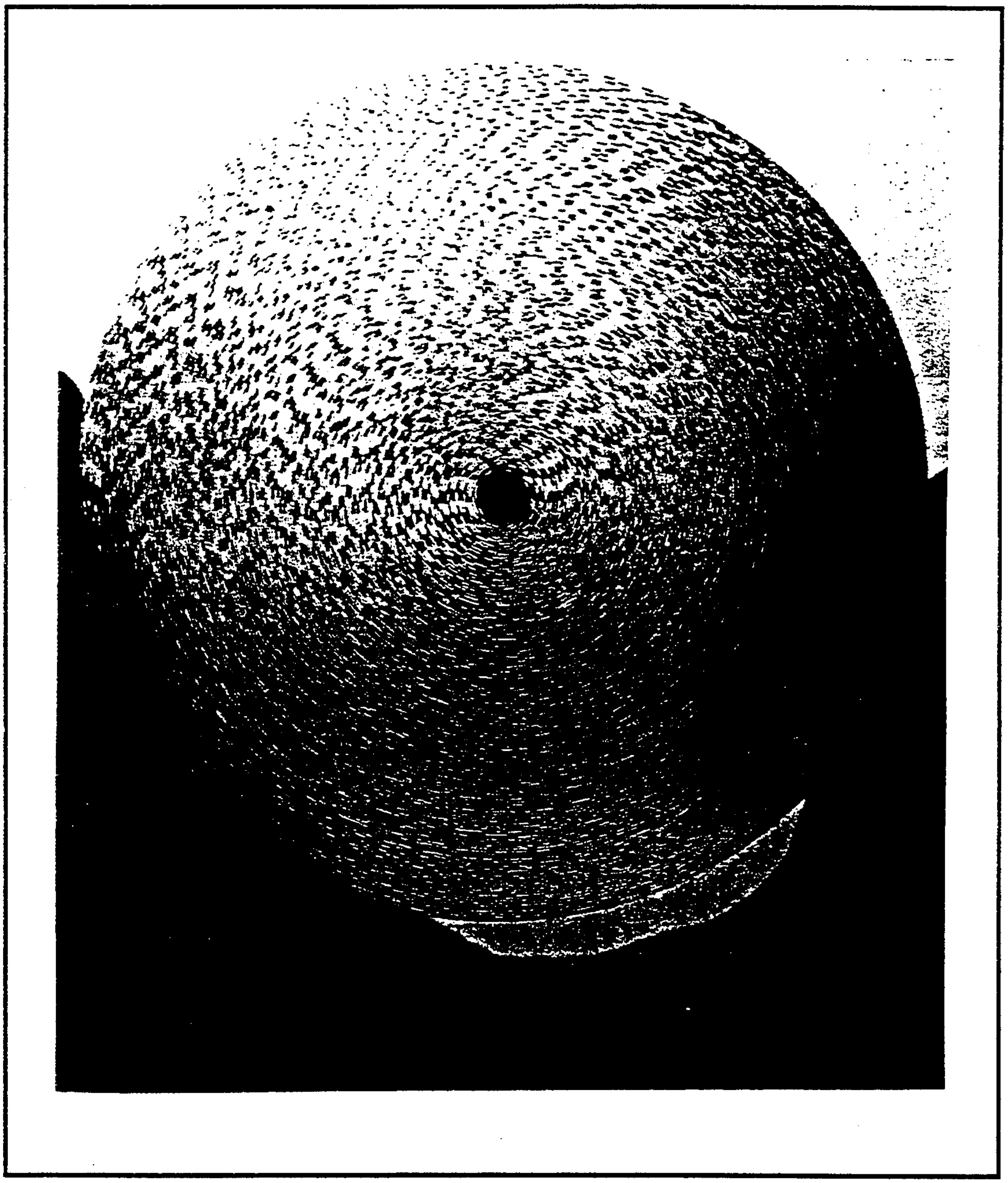

Figure 3. Thermoacoustic Stack.

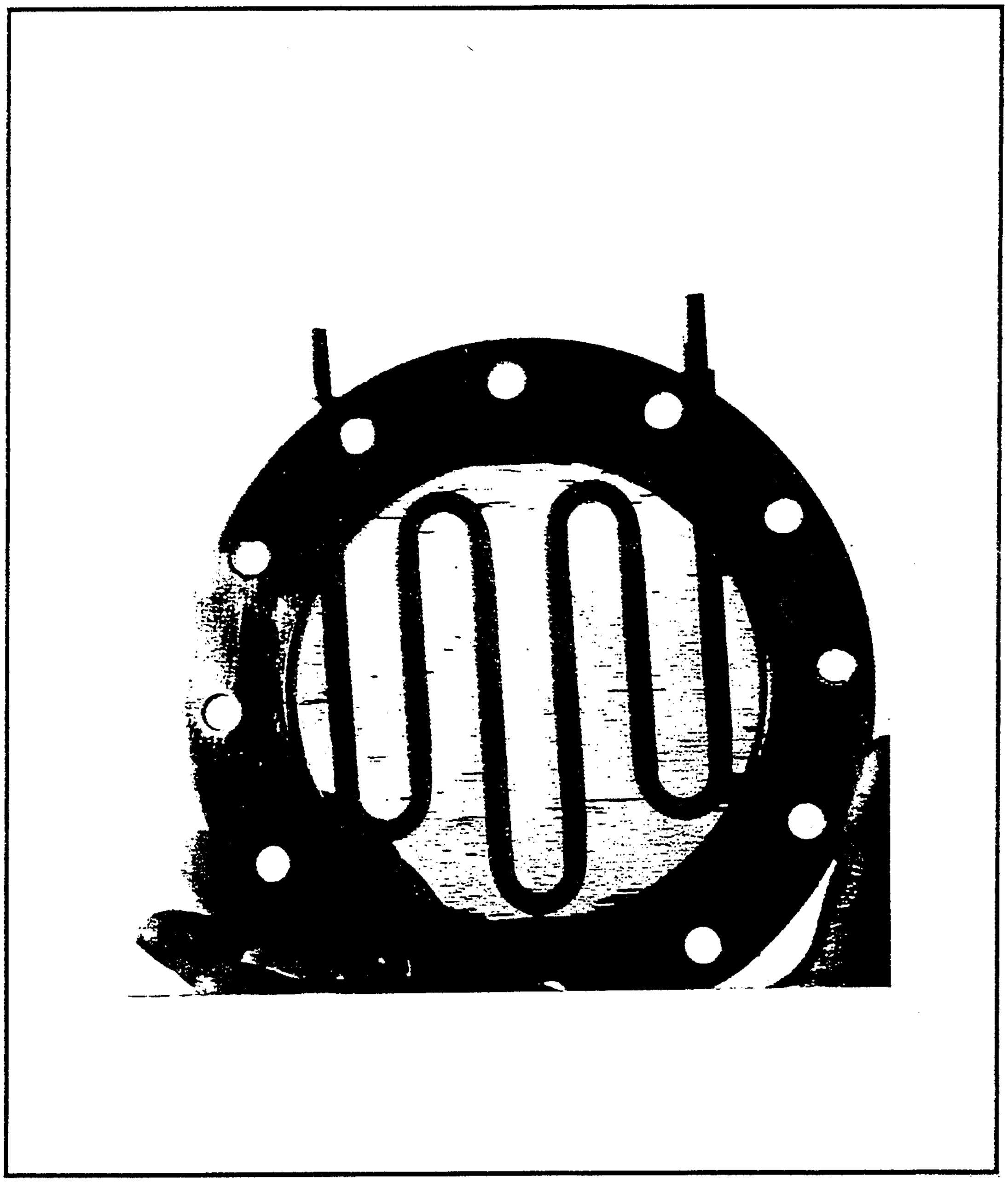

Figure 4. Heat Exchanger.

made an impact in the heat transfer field up to that point. He additionally conducted a preliminary study on how the effect can be related to that of a more traditional fluid-mechanical analysis. Davidson (1974) further expanded upon Richardson's work, analyzing the heat transfer behavior of cylinders in oscillatory flow. That occurred in the early 1970's, and since then, very little work on the subject can be found in literature.

Most recently, though, Mozurkewich (1995) performed heat transfer experiments in an acoustic field utilizing a transient analysis of a heated wire. His results, although informative in some respects, were lacking in data within the most basic flow regimes and his conclusions left some doubt to the reader.

When first attempting to analyze the process behind convective heat transfer in an acoustic field, it is often simpler to think of the heat transfer phenomenon as something akin to that of forced convection due to a steady mean flow. Initially, that there is a separate power source placed away from the test object which produces a disturbance in the fluid medium in which that object is immersed. In forced convection, that power source may be considered to be a fan or a pump which creates a pressure gradient, which in turn causes a steady flow of fluid. In the current problem, the power source is instead an acoustic driver which causes an oscillatory (or vibrational) type of time-periodic flow around the object being considered. This oscillatory flow has a zero-mean and results in no net through flow. Before analyzing this flow for heat transfer characteristics, though, it is necessary to first note which aspects of the acoustic field dominate.

A resonant, standing wave acoustic field excited across the ends of a closed cylindrical chamber has very distinct properties. Of particular interest is the fact that when such a field exists, the pressure along the length of the chamber varies sinusoidally such that a point of maximum pressure occurs at the rigid end termination at the opposite end of the chamber from which the acoustic signal is being generated. In addition, depending upon the frequency being used, there may be more than one zero-crossing, or pressure minimum, along the length of the chamber (Figure 5).

At resonance, the acoustic velocity is out of phase with the pressure. For instance, at a point of minimum pressure, a pressure node, the particle oscillations will be at their point of maximum velocity, a velocity antinode. The reverse then also holds true, (i.e., a pressure

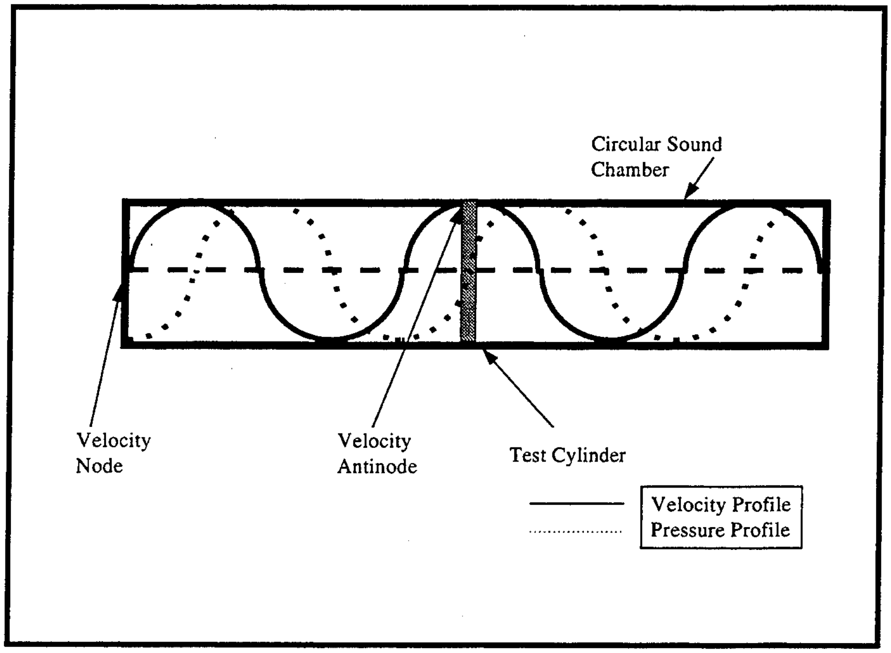

Figure 5. Pressure and Velocity Profiles in a Circular Tube in the Presence of an Acoustic Signal.

antinode can also be designated a velocity node).

To understand the reason why this relationship is extremely valuable to this research, it is useful to again refer to the forced convection model. In general, as the fluid velocity in a forced convection application increases within a particular regime, so does the heat transfer coefficient. The case is essentially the same for heat transfer in an acoustic field, and hence it is expected that the heat transfer rate would also increase as the particle velocity increases. Thus, for experimental purposes it is of prime importance that the test object be placed at a velocity anti-node to get the maximum effectiveness out of the process for a given acoustic signal. However, in contrast to the forced convective mean flow case, the current issue with oscillatory flow is considerably more complicated due to the wide range of flow parameters, and hence flow patterns and heat transport mechanisms, that can result.

II. EXPERIMENT

A. INTENT

As with any other advance in technology or new scientific discovery with which engineers desire to predict and quantify results in some manner, it is best to begin by first breaking the process down into its basic component parts. By completing an analysis for the simplest version of the model in question, a stepping stone will be established upon which the analysis of more complicated scenarios can be built. It stands to reason that this is how the analysis of the thermoacoustic heat transfer process should also begin.

For an initial starting point, the analogy once again to forced convection heat transfer is used. The problem of an isolated cylinder in a mean cross flow is well documented and understood, and has in turn been used to develop correlations for flow over a collection of cylinders, such as a tube bank, a more practical application as is evident from any basic heat transfer textbook. This is the motivation for a study of the behavior of simple shapes such as a cylinder placed in an acoustic field. It is hoped that with this knowledge for an isolated cylinder, it would be possible to extend the solution to other models.

It is only necessary then to concentrate on the evaluation of the acoustic signal itself in terms of its many different parameters. But before this analysis may begin, the type of acoustic flow around the cylinder must be established. To allow corroboration with established theory, the flow pattern initially desired is that of basic laminar, incompressible flow where well understood streaming patterns are the principal forms of flow and heat transport. This meets the requirement for maintaining the most simplified version of flow for the analysis.

The geometry of how the test cylinder is placed with reference to the acoustic signal is also of utmost importance. A theoretically perfect scenario would have the test cylinder situated normal to a unidirectional sound field with no interference from the surroundings. Such a situation cannot be exactly duplicated, though, due to the nature of acoustic waves to spread and travel in all directions. In order to restrict the acoustic signal to only one

direction, it is proposed that the sound field be set up in a cylindrical, resonant sound chamber so that the analysis is properly limited to axial wave modes only.

B. FUNDAMENTAL IDEAS

Unlike the well known dependence on the Reynolds and Prandtl numbers found in conventional cross flow over bluff bodies, the issue of heat transfer in the presence of an acoustic field is significantly more complicated due to the presence of a multitude of competing length (or time, or velocity) scales. The ways in which these length scales may be ordered are many and lead to numerous distinct parameter regimes with quite drastically different flow properties, and hence heat transfer properties. In order to closely examine the properties of heat transfer in oscillatory flows then, it is first necessary to enumerate some of the different parameters and variables involved. By establishing and maintaining a set of criteria surrounding these parameters, and by modeling the test apparatus to conform to them, the job of evaluating different regimes of flow and drawing correlations from the data obtained will become possible.

This section lists the most important of these parameters and provides reasoning for the choices involved, keeping in mind the desire to maintain the most basic and core set of conditions that flow around the test cylinder be laminar, incompressible and attached, and that only the steady-state solution be considered.

1. Criterion A

Following the first assumption that the acoustic streaming flow around the test cylinder be incompressible, two different length scales must be specified. The first of these requires that the relative size of the test cylinder be very small compared to the radian wavelength of the acoustic field, where the radian wavelength is defined as

$$\bar{\lambda} = \frac{\lambda}{2\pi} \tag{1}$$

and the characteristic length scale of the test cylinder is chosen as the radius, a. The radian wavelength can be related to the frequency by:

$$\bar{\lambda} = \frac{\lambda}{2\pi} = \frac{c/f}{2\pi} = \frac{c}{\omega} \tag{2}$$

Now, by asserting that $a \ll \bar{\lambda}$, and designating the ratio between the two as χ, it follows that:

$$\frac{a}{\bar{\lambda}} \ll 1 \tag{3}$$

and finally that

$$\chi = \frac{a\omega}{c} \ll 1 \tag{4}$$

The criterion $\chi \ll 1$ ensures that radiation effects due to the acoustic streaming are negligible, as presented by Lighthill (1963) and indicates that it is only the local acoustic field conditions that are of importance.

2. Criterion B

The second criterion which is required to support the assumption that flow be incompressible is derived from the relationship between displacement amplitude of particle oscillation in the sound field, $\bar{A}$, and the cylinder radius, a. The ratio between the two, $\frac{\bar{A}}{a}$, will be designated as the amplitude parameter, ϵ, and dictates whether or not separation will occur.

When the amplitude parameter is very small,

$$\epsilon = \frac{\bar{A}}{a} \ll 1 \tag{5}$$

the particles in the sound field move a very short distance along the cylinder wall before reversing their direction. This ensures that the flow remains attached, with little chance of separation occurring, and hence the flow will remain laminar at all times. It can also be noted that ϵ is directly proportional to the pressure ratio P_0 / P_m, and can therefore take on much larger values for strong acoustic fields. This is accomplished by observing that the displacement amplitude of a particle in the flow is directly related to its velocity and that the

particle velocity is in turn related to the pressure ratio by the following (in a plane standing sound field)

$$\overline{A} = \frac{U_0}{\omega} \tag{6}$$

and

$$U_0 = \frac{cP_0}{\gamma P_m} \tag{7}$$

therefore

$$\epsilon = \frac{c}{a\omega}(\frac{P_0}{\gamma P_m}) \ll 1 \tag{8}$$

Yet another form of this parameter often used in the literature is called the Keulegan Carpenter number and is defined as $KC=U_0/2af$ and can additionally be expressed as

$$KC = \pi\epsilon \tag{9}$$

Of importance is the fact that the product of the parameters defined in the first two criteria (A and B) is the flow Mach number, which can be defined as

$$M=\chi\epsilon=\frac{U_0}{c} \tag{10}$$

When criteria A and B are satisfied, $M \ll 1$, and this in turn is the second condition which satisfies the assumption of incompressible flow.

3. Criterion C

The Stokes boundary layer thickness δ is related to the kinematic viscosity and the radian frequency of oscillations by

$$\delta = \sqrt{\frac{\nu}{\omega}} \tag{11}$$

and is the well known length scale which is a measure of the extent of viscous effects in an oscillatory flow. A frequency parameter Λ^2 can be defined as follows

$$\Lambda^2 = \left(\frac{a}{\delta}\right)^2 = \frac{a^2\omega}{\nu} \tag{12}$$

For the case when $\Lambda^2 \gg 1$, the Stokes shear layer is confined to a narrow region and the acoustic streaming effect appears as a slip velocity along the cylinder surface. Utilizing the knowledge that the boundary layer thickness is on the order of 10δ and imposing the condition (somewhat arbitrarily) that

$$\frac{a}{10\delta} > 4 \tag{13}$$

it follows that

$$\Lambda^2 > 1600 \tag{14}$$

is a good criterion to ensure "large" values of the frequency parameter.

The frequency parameter may also be often found in the literature in the form of $\beta = (2a)^2 f/\nu$, and can be expressed as

$$\beta = \left(\frac{2}{\pi}\right)\Lambda^2 \tag{15}$$

4. Criterion D

When criteria A - C are satisfied, the acoustic streaming velocity is of magnitude $O(\epsilon U_0)$. A streaming Reynolds number, R_s, can then be defined as

$$R_s = \frac{(\epsilon U_0)a}{\nu} \tag{16}$$

Through substitution for ϵ and U_0

$$R_s = \frac{U_0}{a\omega}\frac{U_0 a}{\nu} = \frac{U_0^2}{\omega\nu} = \frac{c^2}{\omega\nu}\left(\frac{P_0}{\gamma p_m}\right)^2 \tag{17}$$

which yields

$$R_s = \epsilon^2\Lambda^2 \tag{18}$$

This streaming Reynolds number becomes the driving factor in determining what will be the primary mode of heat transport within the region due to the acoustic streaming flow. Stuart (1966) demonstrated that when $R_s \ll 1$, a Stokes flow becomes prevalent in the outer region while a boundary layer flow is predominant when this parameter takes on values much greater than one. In order to ensure that forced convective heat transfer is dominant then, we impose the following constraint

$$R_s \gg 1 \tag{19}$$

5. Criterion E

It was first observed by Honji (1981) that flow around a cylinder will become centrifugally unstable and separate into vortices as the amplitude of particle oscillation increases. This instability occurs in the Stokes layer where the flow is parallel to the direction of particle oscillation. This was confirmed by Hall (1984) who conducted a linear stability analysis on the unsteady boundary layer in the high-frequency limit. He found that a critical value of the Reynolds streaming number exists for which instabilities begin to form, namely when R_s becomes greater than 4.24Λ. Recent work in the area by Sarpkaya (1986) provides further explanation for this phenomenon. Since vortex shedding can make a large impact on the heat transport from the cylinder, we will maintain the following criterion, which can be expressed in two different ways as

$$R_s < 4.24\Lambda \tag{20}$$

or, alternately as

$$\epsilon < \frac{2.06}{\sqrt{\Lambda}} \tag{21}$$

An example of what these vortices may look like is shown in Figure 6.

6. Criterion F

In order to maintain the condition in which there is minimal influence from the buoyancy effects of natural convection as compared to the forced convective heat transfer due to the acoustic streaming effects, a dimensional analysis of the governing equations produces the following requirement for the Grashof number

$$\frac{Gr}{R_s^2} \ll 1 \tag{22}$$

For the case when $Gr \,/\, R_s^2 \approx 1$ or greater, buoyancy effects must be taken into account and any heat transfer correlations developed will have to be modified accordingly.

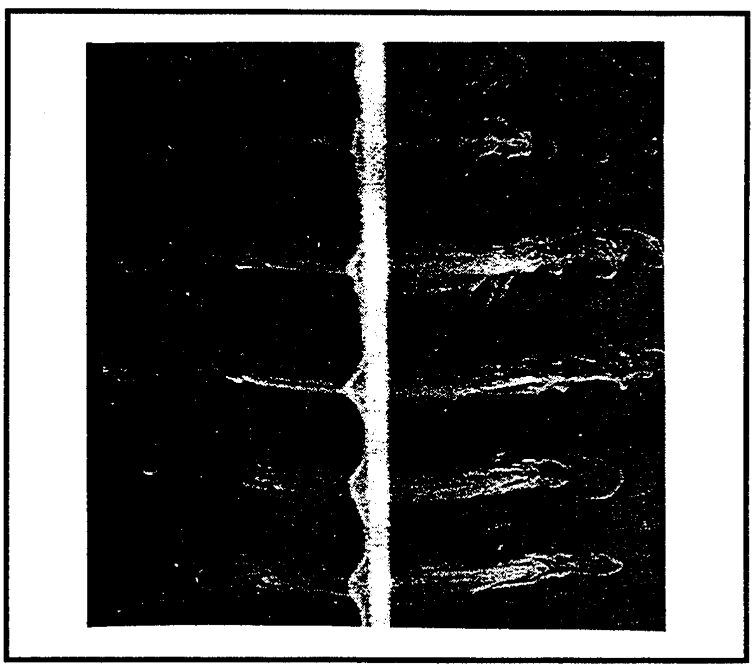

Figure 6. Vortices Due to Oscillatory Flow Around a Cylinder. (Sarpkaya, 1986)

7. Criterion G

This final criterion stems from the desire to maintain only a plane standing sound field within the test chamber. This means that only the axial wave components excited by the resonant acoustic signal be present, without interference from transverse modes such as the azimuthal modes and radial modes. It may be shown from theory that there is a certain cut-off frequency developed from a solution of the wave equation, below which the transverse modes will not be present. For the cylindrical waveguide geometry being used, the solution for the above condition is obtained in the form of appropriate roots of Bessel functions. If L is the length of the test chamber, the longitudinal frequency can be expressed as

$$f_l = \frac{lc}{2L} \tag{23}$$

where l is the 1st, 2nd, ... , mode number. The transverse frequency mode is expressed by

$$f_{mn} = \alpha'_{mn} \frac{c}{\pi D} \tag{24}$$

where D is the test chamber diameter and α'_{mn} represents the eigenvalues obtained from roots of the Bessel functions. Transverse modes will be present if $f_l = f_{mn}$, so it is desired to maintain f_l well below f_{mn} and f_l now represents the maximum frequency possible while still maintaining this criterion. By substituting for both frequencies, the condition becomes

$$\frac{lc}{2L} < \alpha'_{mn} \frac{c}{\pi D} \tag{25}$$

which is reduced to

$$\frac{l}{2(\frac{L}{D})} < \frac{\alpha'_{mn}}{\pi} \tag{26}$$

By introducing a new parameter called the aspect ratio,

$$Z = \frac{L}{D} \tag{27}$$

and finding the smallest root of this Bessel function,

$$\frac{\alpha'_{mn}}{\pi} min = 0.586 \tag{28}$$

the criterion now becomes

$$\frac{l}{2Z} < 0.586 \tag{29}$$

which can be rearranged to finally get

$$Z = \frac{L}{D} > 0.85 \; l_{\max} \tag{30}$$

where

$$l_{\max} = \frac{f_{\max}}{f_{\min}} \tag{31}$$

This gives a relationship between the geometry and the maximum frequency. But since the maximum frequency is already defined using criteria A - F, criterion G in fact gives us the maximum diameter that can be used, or if the diameter is also given, it determines the length of the chamber instead.

8. Basic Flow Description

When a cylinder is immersed in a standing acoustic field and all of the previous criteria have been met, particle oscillations will initiate the most basic form of an acoustic streaming flow. This steady flow (Figure 7) is symmetrical about two axis, is circular in nature, and includes a well defined boundary layer. The boundary layer is actually quite small and is greatly exaggerated in the figure for clarity. Although this is not the only flow which is present, it does represent the flow pattern that has the biggest impact as a heat transport mechanism when these criteria are satisfied.

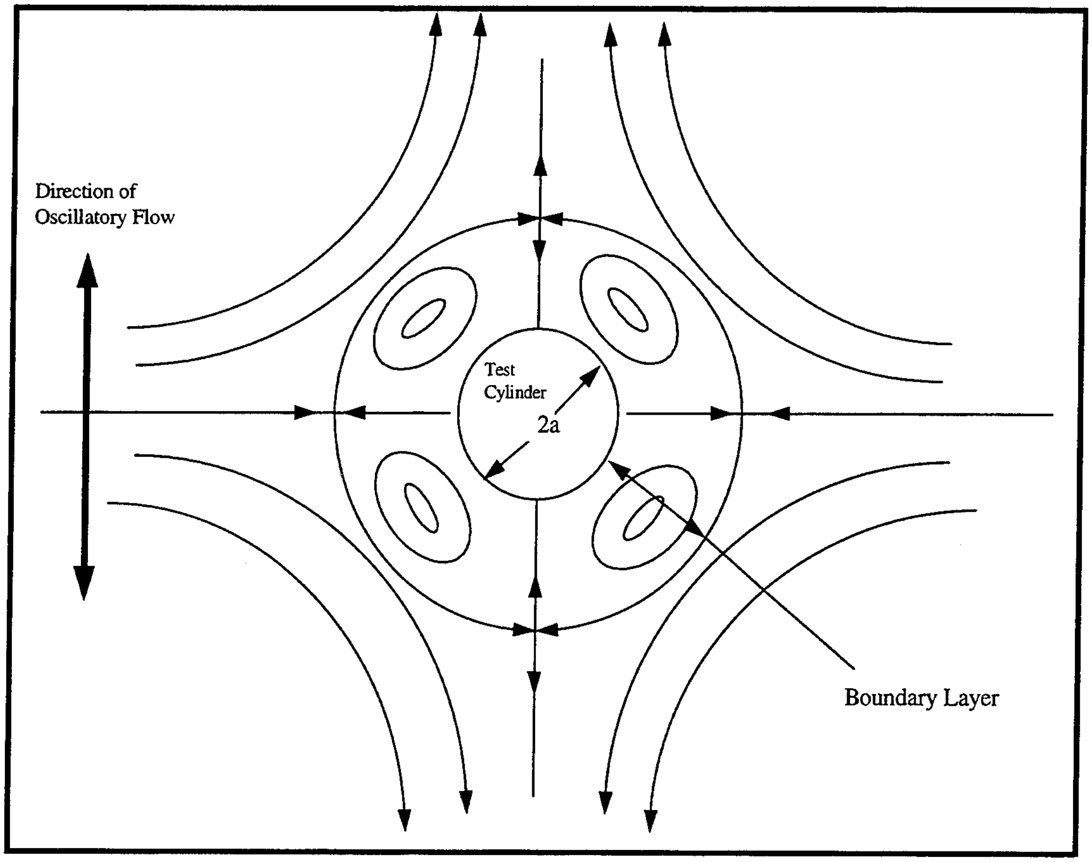

Figure 7. Outer Acoustic Streaming Flow (also known as Boundary Layer Flow)

As discussed earlier, this fluid flow regime is the main focus of this investigation in which at first we consider only laminar, unseparated flow around the test cylinder. One of the goals of this experimental study is to determine the range of values for the previously discussed parameters where one flow regime transitions to another and relate them in terms of the streaming Reynolds number. It is believed that such transitions will be reflected in the heat transfer behavior.

In order to define a specific range for laminar flow, though, these criteria needed to refinement by asking the questions; how small is "much less than one" or how big is "much

greater than one"? It was determined that Criterion A in Eq. 4 would be met by picking $\chi < 0.1$ and Criterion B in Eq. 5 would be met by choosing $\epsilon < 0.3$. This ensures incompressible flow around the test cylinder and that flow remains attached. Criterion C becomes $\Lambda^2 > 1600$, confining the Stokes shear layer to a narrow region. The above ranges have been fixed based on prior experience and preliminary experimentation, but are not by any means intended to be "hard and fast". They may indeed be modified if necessary. Criteria D and E require verification after each experimental run.

C. APPARATUS

As previously discussed, the experiment consists of a heated test cylinder placed normal to a simple acoustic standing wave within a resonating sound chamber (Figure 8). This general description can be broken down into three major components; the test cylinder, the sound chamber and the acoustic electronics package, which are further described below.

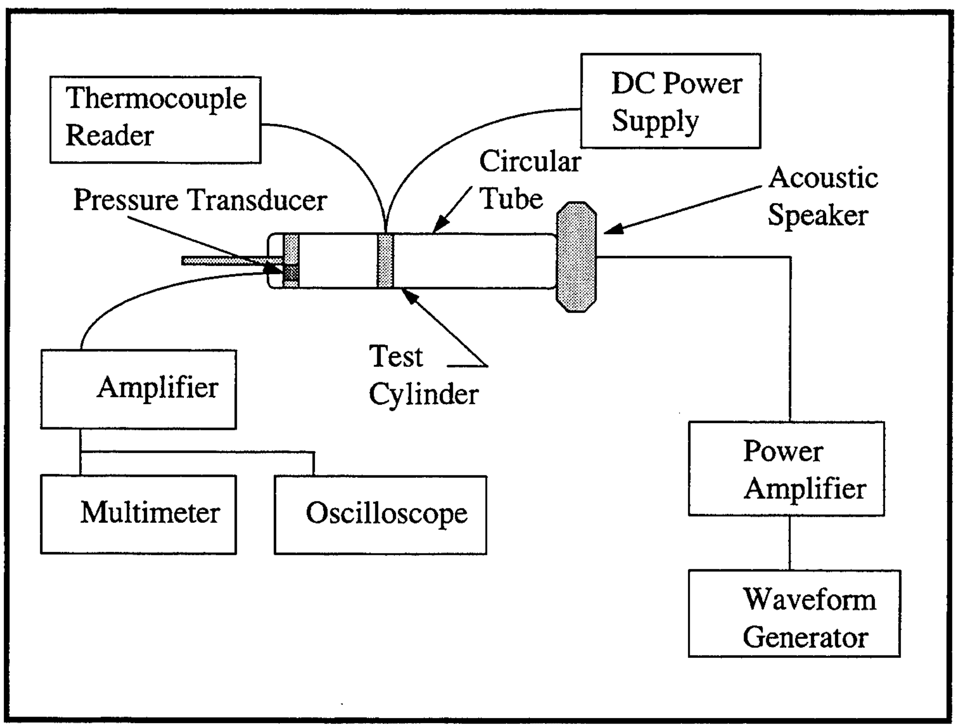

Figure 8. Experimental Test Apparatus.

1. Test Cylinder

It was originally proposed that a Watlow stainless steel cartridge heater be used as the test cylinder for the experiments. They are available in varying diameters and additionally feature an imbedded type "J" thermocouple placed at the midpoint of its length. This presented problems, however, since the heating along the length of the cartridge heater was uneven and the relatively large thermal resistance of the stainless steel produced large variances in surface temperature along the length. Since constant surface temperature is a feature which is very important to the analysis of heat transfer characteristics, this was unacceptable. Therefore, a copper sheath was designed to fit over the cartridge heater. It was assumed that the large thermal conductivity of copper would even out the axial surface temperature gradient. In addition, silicon oil was liberally applied to the inside of the copper sheath prior to insertion of the cartridge heater before each experimental run (Figure 9). This provides better thermal contact in the narrow annular gap (approximately 2 mm) between the sheath and heater, preventing air gaps which can cause local temperature discontinuities at the surface. This arrangement (as was later verified, Appendix B) provides for an axial temperature variation of less than 0.5°C from one end of the heater to the other for the temperature range of interest in this experiment. A picture of the test cylinder is shown in Figure 10.

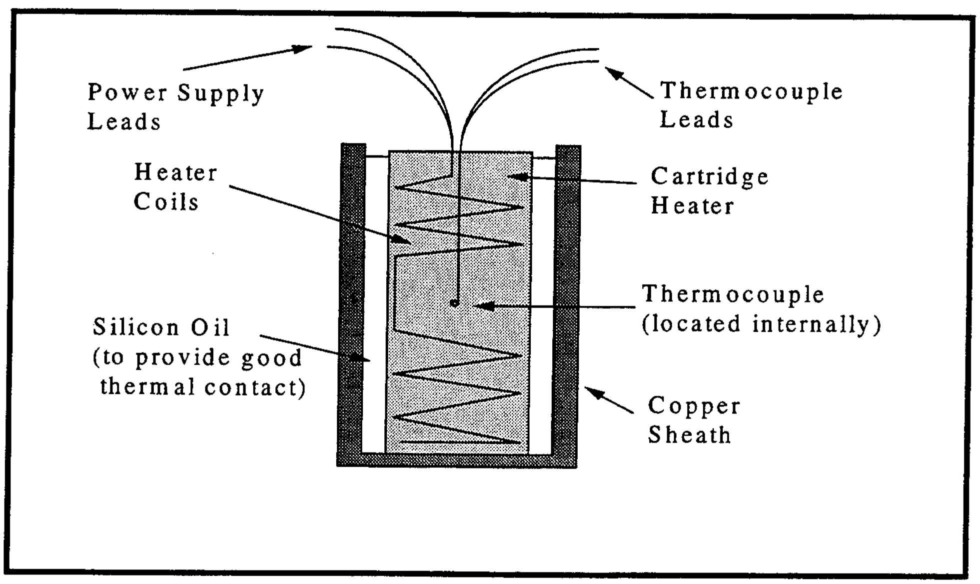

Figure 9. Test Cylinder Assembly.

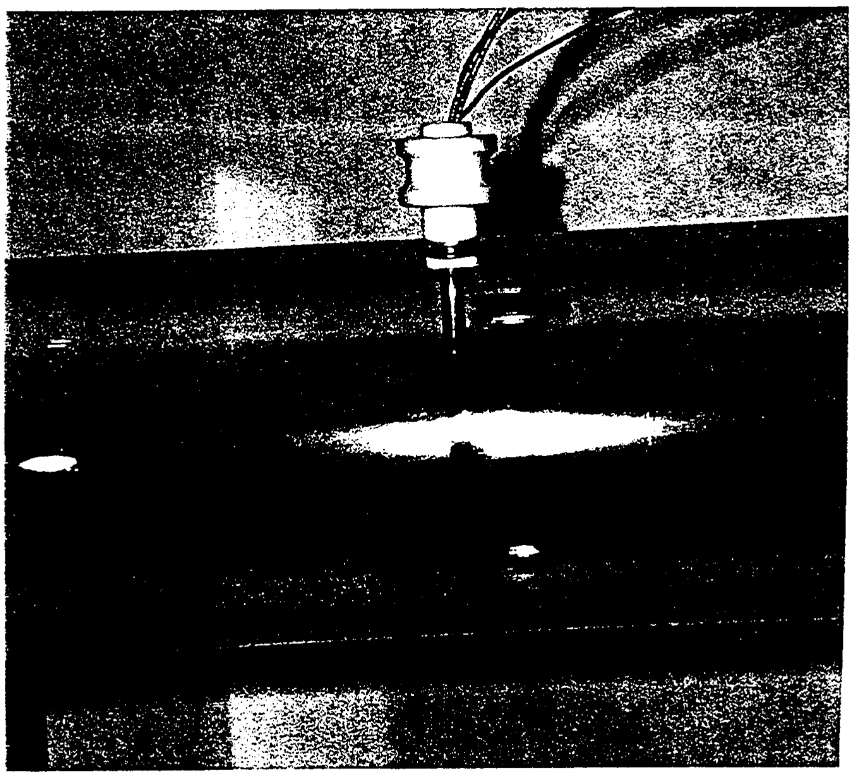

Figure 10. Photo of Test Cylinder inserted into the Sound Chamber.

As was stated earlier, the surface temperature of the test cylinder is a required datum point for the analysis. Since the only provision for temperature measurement is at the thermocouple placed at the center of the test cylinder, the equivalent resistance of the steel/oil/copper circuit is required in order to deduce the surface temperature from the cartridge heater center temperature as measured by the imbedded thermocouple. Appendix B gives a detailed analysis of the derivation of the resistance, which is approximately 1.019 K/W.

The cartridge heater receives its power from a Kikusui Model PAR 160A regulated DC power supply. It provides power control measurement down to 0.01 amps and 0.01 volts. Thermocouple measurements are provided by a Keithley Model 740 scanning thermometer system. Calibration data for all thermocouples and the thermocouple reader is provided in Appendix B.

2. Sound Chamber

The purpose of the sound chamber is to provide an environment through which acoustic signals of various frequencies can be used to excite a resonant standing wave. In order to accomplish this for all frequencies which may be used during the experiment, a resonant chamber that would be adjustable in length was highly desired. Figure 11 shows the final configuration of the test chamber while Figure 12 shows a photo of the test apparatus.

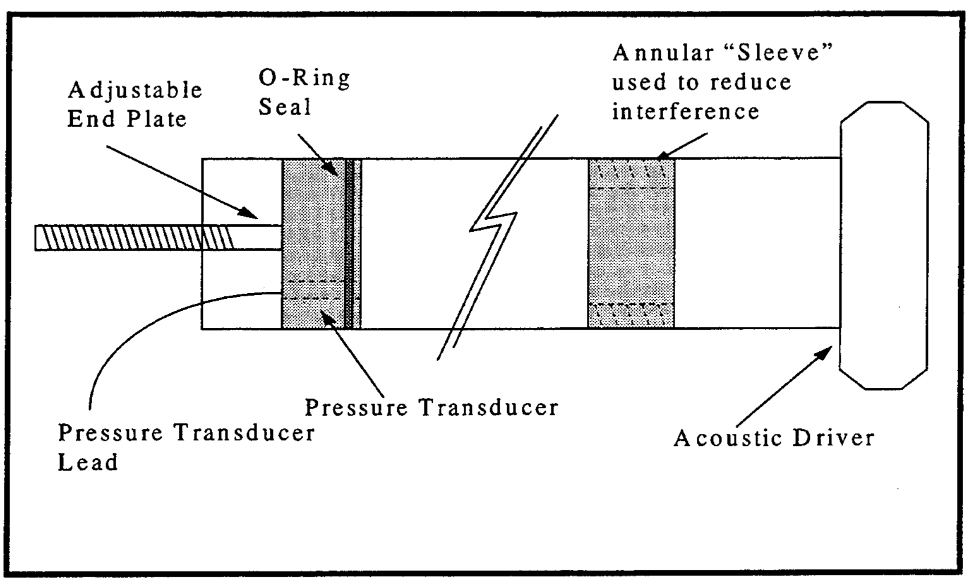

Figure 11. Sound Chamber Assembly.

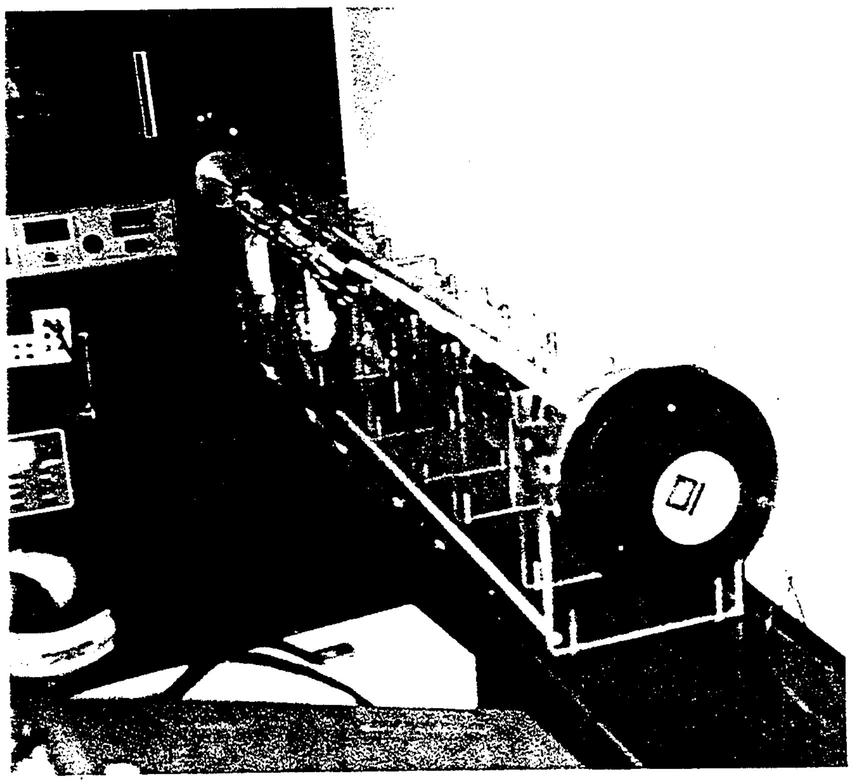

Figure 12. Photo of Test Apparatus. Acoustic Driver is on to the right.

The test chamber itself is a plexiglass tube approximately two meters long which is mounted firmly to a plexiglass base plate. The acoustic driver is mounted at one end and provides the source of the acoustic signal. The opposite end has a movable flat end plate which has an o-ring seal to help isolate the acoustic wave in the chamber. The end plate serves as the rigid end termination while the o-ring provides good sound confinement, as well as good stability for the end face so that it doesn't become offset to either side as its position is varied along the length of the enclosing resonant chamber.

A hole through this end plate provides access for a pressure transducer which is used to help deduce the pressure ratio, and hence the sound pressure level for that configuration of frequency and input power. The pressure transducer used is an Endevco model 8510B-5 which has an output in millivolts and has a pressure sensitivity of 50.89 mV/psi. This is connected to a preamplifier with a gain of 100 and provides output to both an oscilloscope and a Hewlett-Packard model 34401A multimeter. Measurement of the voltage output from the multimeter is important to determine when resonance has occurred within the chamber for as the frequency is varied, the output voltage from the microphone decreases on either side of the resonant operating point.

The oscilloscope provides a visual representation of the time trace of the acoustic signal at the end of the sound chamber, corresponding to a pressure antinode, and is used to ensure that the signal remains sinusoidal throughout the experimental range of powers and frequencies. During the initial stages of the experiment, the oscilloscope allowed for the discovery of interference patterns in the sinusoidal waveform as caused by higher order harmonics at high SPLs (> 155 dB). In order to limit the interference that was present, the use of "sleeves" within the chamber was recommended to detune the resonant mechanism. This would prevent the harmonics from being integral multiples of each other and thereby prevent them from reinforcing each other to form interference patterns. By placing a sleeve at an appropriate spot in the chamber, some of the high frequency harmonics leading to interference could be eliminated, allowing for even higher SPLs to be achieved before interference occurred.

3. Acoustic Electronics Package

Of great importance to the experiment is the ability to generate a nearly pure sinusoidal waveform at varying frequencies and high power ranges. As the strength of the signal generated increases, the effect of the flow around the test cylinder becomes more pronounced, enhancing the heat transfer characteristics of the system.

The acoustic signal being generated at the driver end of the sound chamber is provided by a Hewlett-Packard model 33120A arbitrary waveform generator. It sends a sinusoidal waveform at the proper frequency through a Techron model 7540 power supply amplifier to a JBL model 2490H acoustic compression driver.

A more detailed review of each item of equipment used in the system is provided in Appendix D.

D. EXPERIMENTAL METHOD

Prior to gathering data for this experiment, it was first necessary to develop a coherent plan with which to approach the problem. The first step required was to find specific frequencies at which resonance occurred within the chamber, and which would also provide a velocity anti-node at the position of the test cylinder. By looking at the geometry of the problem (Figure 13), it became obvious that these limiting factors could be met by a combination of adjusting the end plate distance from the test cylinder, as well as the signal frequency, so that the length L from the heated cylinder to the end plate termination was an odd multiple of $\lambda/4$. This could be further refined to state that the value of $4Lf/c$ needs to be an odd integer. When this condition was satisfied, the requirement of a velocity anti-node occurring at the cylinder location was met.

The next thing needed was an estimate of the maximum pressure ratio, and therefore the sound pressure level that could be obtained. This was achieved by increasing the amplitude of the input signal waveform until the output waveform on the oscilloscope began showing traces of interference or other disturbances. When the maximum input amplitude was obtained, the multimeter output was recorded.

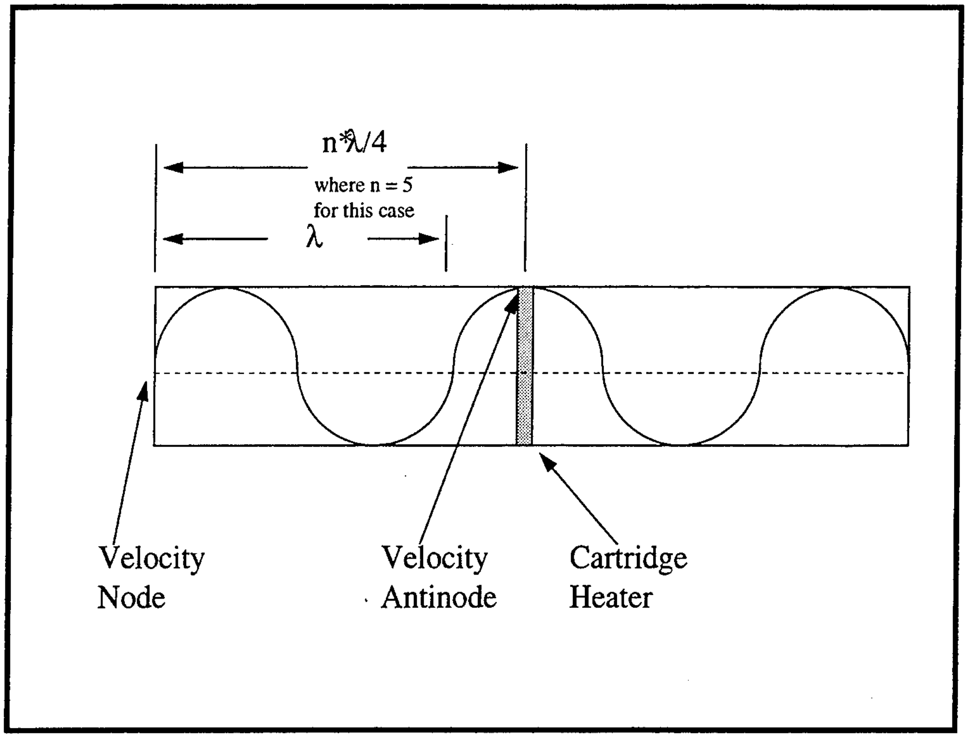

Figure 13. Proper Geometry so that Maximum Velocity occurs at the Test Cylinder.

In order to convert the output voltage to an actual pressure ratio and sound pressure level, it was necessary to first understand what form the multimeter uses to present the output. The multimeter gives the voltage output in terms of the true RMS value of the sinusoidal signal, or rather $V_0/\sqrt{2}$, where Vo represents the voltage amplitude from zero to peak of the sinusoidal signal. Recall that the true RMS value for the pressure can also be expressed as $P_0/\sqrt{2}$. Then, the following relationship holds true, that

$$P_0/\sqrt{2} = \frac{V_0/\sqrt{2}}{S} \tag{32}$$

where S is the sensitivity of the pressure transducer in mV/Pa.

The sensitivity of the pressure transducer after passing through the 100 gain setting of the preamplifier was converted and expressed as 0.74 mV/Pa. By substituting into the above equation, the pressure amplitude becomes

$$P_0 = \frac{V_0/\sqrt{2}}{0.523mV/Pa} \tag{33}$$

where it is noted again that $V_0 / \sqrt{2}$ is the multimeter output.

From this, a pressure ratio can be defined as

$$PR = \frac{P_0}{P_m} \tag{34}$$

where P_m is the mean ambient pressure of 101 kPa. The pressure ratio is typically expressed in terms of a percentage.

The sound pressure level is defined as the logarithmically scaled ratio of the RMS pressure and a predetermined reference pressure, P_{ref}, where P_{ref} is chosen to be 20 μPa for gases (by convention). This gives

$$SPL = 20 \log_{10} \frac{P_0/\sqrt{2}}{P_{ref}} \tag{35}$$

In order to obtain an idea of how strong the acoustic signal is during the experiments, Table 1 gives the sound pressure level for various activities

Activity	Sound Pressure Level (dB)	Pressure Ratio (%)
Normal Conversation	60	< 0.001
Jet Airplane at Take-off	90	< 0.01
Pain Threshold	120	0.28
Minimum Experimental Level	150.6	0.94
Maximum Experimental Level	161.2	3.20

Table 1. Samples of SPL and PR for Comparison.

After finding the pressure ratio, and therefore the SPL, the actual data extraction phase of the experiment could be initiated. It was preceded by with an understanding of what

type of data was needed for analysis. A crucial element of this experiment is the need to obtain a broad base of data with which to incorporate the results. In order to obtain this, experiments were run at several different pressure ratios for each resonant frequency found, starting from as low as 0.9% and building up to the maximum pressure ratio by increments of 0.1%. In order to obtain a spread of data points at each pressure ratio evaluated, the test cylinder was heated to approximately 8, 12 and 16 degrees above the ambient temperature. This kept the power requirements low and reduced the amount of thermal input into the ambient air within the sound chamber. This latter point was necessary as the ambient temperature could rise as much as 0.3 degrees during a single experimental trial. In order to ensure reproducibility and reduce the effect of anomalistic behavior, three runs at each temperature point were conducted to ensure consistency of data. The selected temperatures were only guidelines and were not meant to be hard set points for the experiment. Instead, they were treated as aim points with an acceptable range of ± 1 degree. Therefore, in order to produce an even broader spread of data, the power input to the test cylinder was varied slightly for each of the three trials at each specific temperature point.

Once the selected frequencies and pressure ratios had been determined and a suitable starting pressure ratio and temperature had been obtained, the experimental process was initiated. In order to obtain the selected pressure ratio for a particular set of runs, it was necessary to get an idea of the settings required for each specific piece of equipment. This was done by selecting the appropriate frequency on the waveform generator and modifying the power amplification on both the waveform generator and the power amplifier until the appropriate pressure ratio was obtained from the multimeter. The frequency was then adjusted to fine tune the resonance. A check of the oscilloscope at this point ensured that the signal being generated was of the right waveform and that interference was not occurring. Then the power amplifier to the acoustic driver was turned down to zero after noting the level at which it was set. This allowed for obtaining the correct pressure ratio in a quick manner by simply turning the power amplifier up to the previously noted value.

It was necessary at this point to ensure that the test cylinder was properly prepared. This entailed introducing approximately ten drops of silicon oil into the copper sheath and

inserting the cartridge heater. The cartridge heater would be completely immersed in the silicon oil after being fully inserted. After a period of time, there would be some loss of silicon oil due to the wick action of the thermocouple and power leads emerging from the top. This was insignificant during the runs required for a single pressure ratio and caused a negligible change in the center-to-surface resistance as noted in Appendix B, but it became good practice to add some of drops of oil each time a new set of runs at a different pressure ratio were to be taken.

The test cylinder was then inserted into the sound chamber, making sure that the bottom of the cylinder was resting in a shallow indentation specifically machined into the inside face of the chamber. Power to the cartridge heater was then turned on and set so that a steady state temperature of approximately eight degrees above ambient would occur when the acoustic signal was present. This became more of an art form and required familiarity with the system to accomplish it with any degree of accuracy.

Since the power to the acoustic driver at this point was still at zero, the power to the cartridge heater would drive the temperature of the test cylinder past the projected steady state temperature. As it approached the projected temperature, though, the power to the acoustic driver was increased to the previously noted set point. This provided the fluid flow at the predetermined pressure ratio, in effect beginning to cool the test cylinder until it reached a steady state condition. At this point, the rate of energy input to the cylinder was equal to the rate of energy being convected away from the cylinder. By monitoring the interior thermocouple temperature, it was easy to see when the lowest temperature was reached. When the temperature began to rise once again, it was determined that the steady state condition had been reached and that the resultant temperature rise being witnessed was due only to the test cylinder transferring heat into the surrounding fluid medium, thus raising the overall ambient temperature.

Two situations other than the ideal one presented above occurred frequently due to the coarse means of trying to arrive at the desired cylinder temperature. If upon engaging the power to the acoustic driver the temperature of the test cylinder did not decrease but continued to increase at a slower rate instead, then the power being supplied to the cartridge

heater was deemed too high and the voltage reduced until a decrease in temperature was witnessed. If upon engaging power to the acoustic driver the temperature of the test cylinder were to continue decreasing lower than the desired temperature range, it was an easy matter to increase the voltage to the cartridge heater to increase the steady state temperature solution.

When the steady state solution point was reached, the frequency and microphone voltage were noted, as was the voltage and current supplied to the cartridge heater and the temperature of the thermocouple in the cartridge heater. The power to the heater and the power to the acoustic driver were then simultaneously turned off and the test cylinder was quickly removed from the sound chamber. A second thermocouple was then introduced through the access hole in the sound chamber (from which the test cylinder had just been removed) such that the location of the thermocouple was approximately at the center (i.e., along the axis) of the sound chamber. This thermocouple temperature was then monitored until it "plateaued" and provided the measurement of the ambient temperature within the sound chamber.

This completed a single experimental trial for a specified resonant frequency, pressure ratio and temperature. The procedure was carried out a total of nine times for each different pressure ratio. Once the six outputs for each run were recorded, they were then transferred over to a spreadsheet where all other significant parameters were computed automatically. The following section delineates the various calculations performed in the spreadsheet.

E. EXPERIMENTAL CALCULATIONS

The first calculation desired from the spreadsheet entails finding the actual power being supplied to the cartridge heater. This is expressed in terms of the current and voltage outputs from each experimental run.

$$P = IV \tag{36}$$

Once the power to the cartridge heater was known, the surface temperature of the test cylinder itself could be calculated. Knowing the resistance of the thermal circuit as given in Appendix B, the difference between the interior temperature and the surface temperature is simply

$$\Delta T = PR_{eq} \tag{37}$$

Utilizing the interior temperature output as provided by the thermocouple embedded in the cartridge heater, the surface temperature of the cylinder is then expressed as

$$T_s = T_c - PR_{eq} \tag{38}$$

Once the surface temperature is known, the difference between it and the ambient temperature, as measured during the experiment, is calculated. The result is then combined with the power calculated in Eq. 35, as well as with the external surface area of the test cylinder, to find the convective heat transfer coefficient

$$h = \frac{P}{A(T_s - T_a)} \tag{39}$$

The Nusselt number is then derived from the following equation

$$Nu = \frac{hd}{k} \tag{40}$$

where d is the test cylinder diameter and k is the thermal conductivity of air.

The next step is to calculate the various criteria as previously listed in the theory section. In order to find the length scale ratio, χ, the speed of sound within the chamber must first be calculated using the ambient temperature

$$c = \sqrt{\gamma R(T_a + 273.15)} \tag{41}$$

The value of χ can now be found from Eqs. 1 - 4. The amplitude parameter, ϵ, is derived in the spreadsheet by combining the pressure ratio from Eq. 33 along with Eq. 8. The third parameter calculated is the frequency parameter, Λ^2, from Eqs. 10 and 11.

The streaming Reynolds number, R_s, is found by using Eq. 16. This, however, does not represent the true value at the test cylinder position due to its not being precisely at the velocity antinode. A corrected value for R_s can be deduced by finding the particle velocity offset between the velocity antinode location and the test cylinder position. This offset is derived by knowing the frequency of the sinusoidal signal being generated, the speed of sound within the chamber from Eq. 40, and the distance from the test cylinder to the end plate termination face, L. Hence

$$U_{0_{corrected}} = U_0 |\sin(\frac{4L}{c/f} \frac{\pi}{2})| \tag{42}$$

or

$$U_{0_{corrected}} = U_0 | \sin (\frac{2\pi L}{\lambda}) | \tag{43}$$

Since R_s is proportional to U_0^2, it then follows that

$$R_{s_{corrected}} = R_s |\sin(\frac{2\pi L}{\lambda})|^2 \tag{44}$$

from which it was found that the corrected value for R_s had less than a 0.1% error due to the slightly displaced location of the cylinder.

IV. RESULTS AND DISCUSSION

Nearly 600 experimental trials were performed throughout the course of this study which produced results for 183 distinct data points. Data were obtained for five different frequencies at various pressure ratios ranging from 0.9 % to 3.2 %. Three separate series of trials were performed at each acoustic signal setting, (i.e., at each frequency and pressure ratio setting) corresponding to three separate settings for the driving temperature difference between the test cylinder surface and ambient conditions. The resultant values of the streaming Reynolds number ranged from 40 to 1070 while the corresponding Nusselt numbers obtained varied from 8 to 38. Figure 14 is a parameter map as suggested by Richardson (1967) which shows the range of values for the experimental data covered plotted as a function of the amplitude parameter versus the frequency parameter, and delineates the expected different regimes of flow. The data obtained cover a very narrow regime of this parameter map as was intentionally planned for this experiment. Now it can be seen that the heat transfer results obtained through experimentation are quite evenly distributed between two distinct regions on the map. Region A represents the regime in which the flow is expected to remain laminar, incompressible and attached, and outer acoustic streaming is the main heat transport mechanism. This region is well understood in theory but has yet to be thoroughly verified through experimentation. It is anticipated that the heat transport mechanism for the data in region B will be presented as a combination of effects, including that of vortex shedding, as predicted by Honji (1981), Hall (1984) and Sarpkaya (1986).

The heat transfer results are presented as plots of Nu vs. R_s (Figure 15). Here the difference between the two regions of varying heat transport mechanisms becomes more apparent. A break clearly occurs in the region where $R_s \sim 240$ ($\pm$ 20) and it can be concluded that there is some critical point in this range where there is a transition in the flow at which vortex shedding begins to become a dominant factor in the heat transport away from the test cylinder. In order to better examine the differences between these two regimes, the data is divided into their respective groups and individually analyzed.

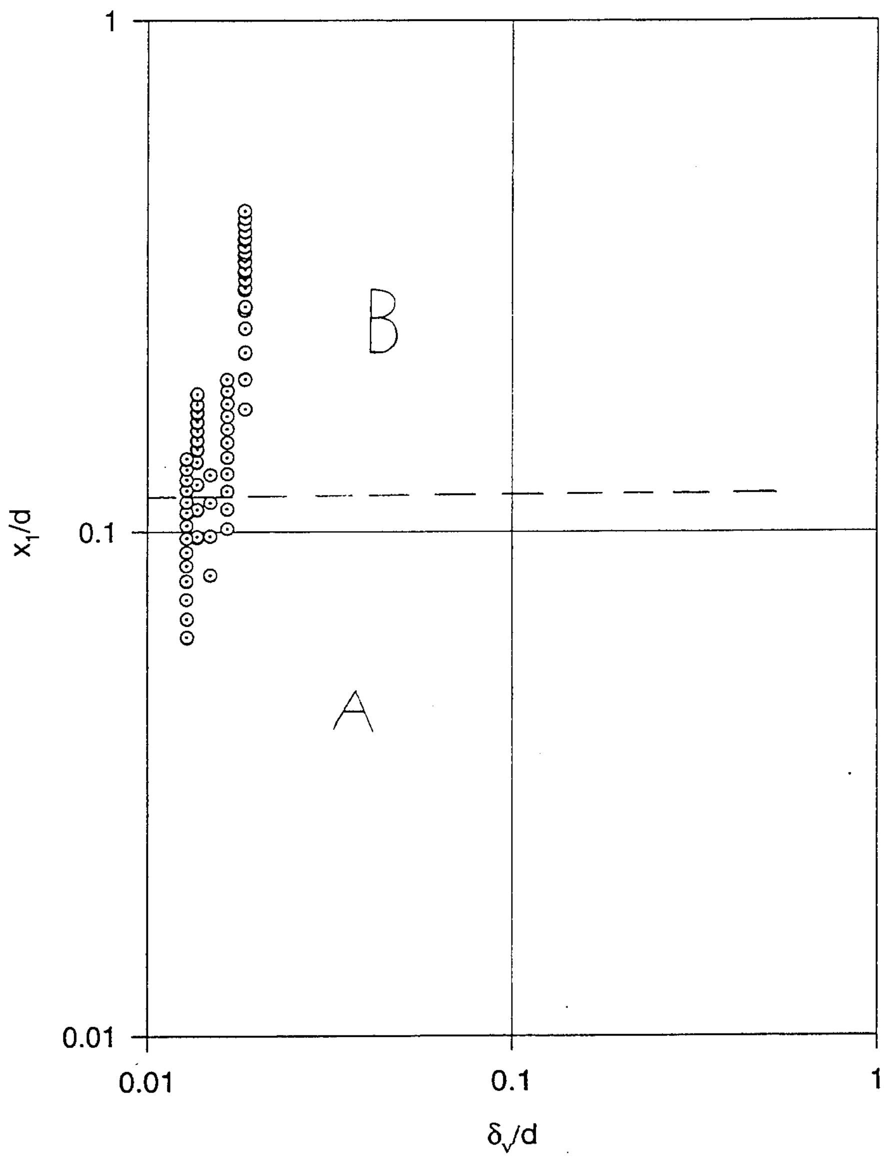

Figure 14. Parameter Map of Expected Heat Transfer Regimes as presented by Richardson (1963): Convection by Inner Acoustic Streaming (A), by Outer Acoustic Streaming (B).

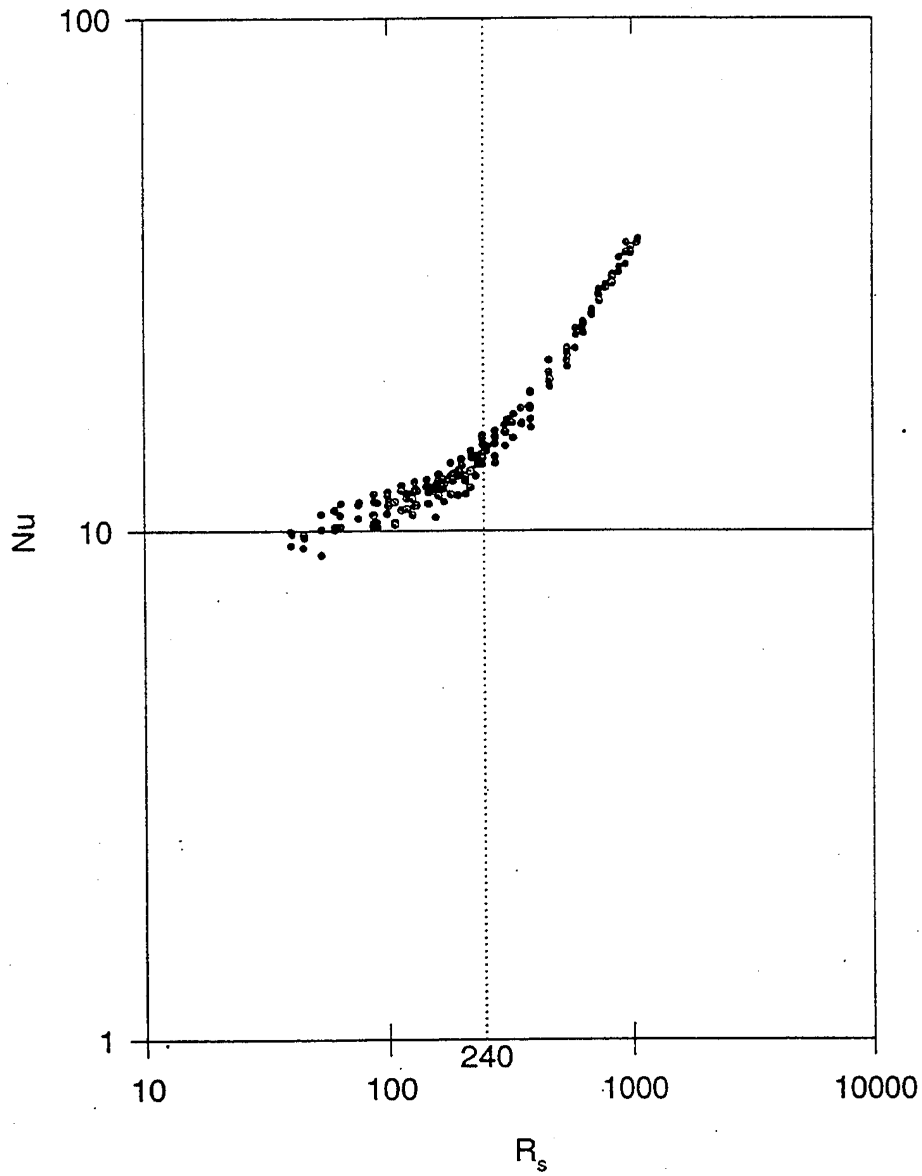

Figure 15. All Data Plotted as a Function of Nusselt Number vs. Streaming Reynolds Number.

A. LAMINAR, ATTACHED FLOW REGIME

Figure 16 is a plot of the heat transfer results in terms of the Nusselt number versus the streaming Reynolds number for the data in which $R_s < 240$, and for which criteria A through C (Eqs. 4, 5, 15) have been met. Those data points which do not meet these criteria have been disregarded. The critical parameters for the remaining data are as follows:

- $\chi < 0.1$
- $\epsilon < 0.3$
- $\Lambda^2 > 1800$
- $\dfrac{R_s}{\Lambda} < 4.5$

Theory clearly indicates that the dependency of the Nusselt number on the streaming Reynolds number in this regime is of the form $Nu = xPr^yR_s^{0.5}$. Since the Prandtl number remains constant throughout the experiment, the solution for this dependency be can further simplified as $Nu = CR_s^{0.5}$, where the term "C" encompasses both the Prandtl number and the qualitative constant of the previous equation. However, this solution form is only valid for "large" values of R_s. Since the theory does not provide a definite limit for what qualifies as "large", this criterion had to be determined from a careful examination of the experimental data. From Figure 16, it can be observed that there is indeed a break point at $R_s \sim 130$ where the results diverge into two separate solutions. It was found that the square-root dependency on R_s does not significantly change past this value, and it is therefore suggested that this may be in the range of the lower limit of "large" values of R_s. For those values in which $R_s > 130$, a curve fit of the heat transfer characteristics results in a solution of the form

$$Nu = 0.94R_s^{0.5} \tag{45}$$

and it can therefore be determined that the range of values $130 < R_s < 240$ is representative of "large" values of the streaming Reynolds number. The values below $R_s = 130$ are excluded as not being large enough due to a variety of reasons as described later.

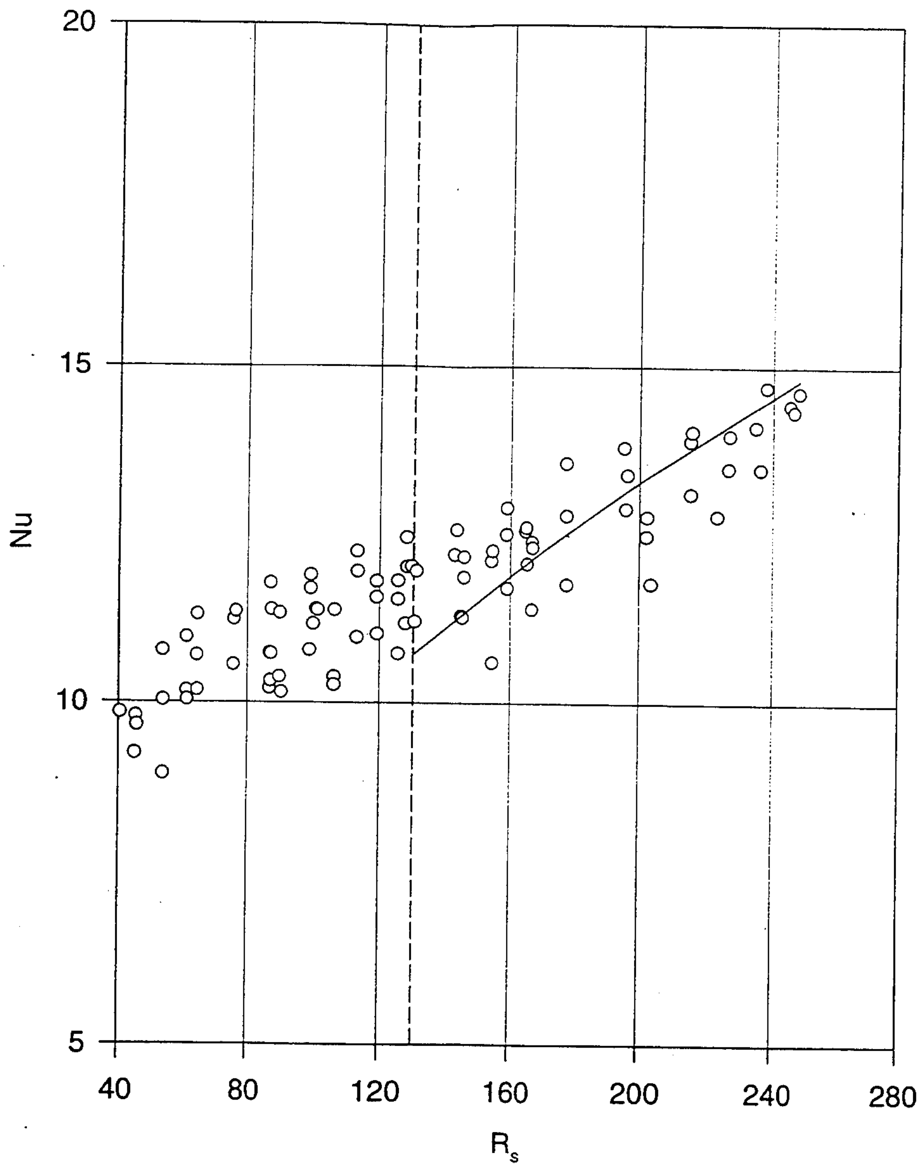

Figure 16. Laminar, Attached Flow Regime for $R_s < 240$ (Curve Fit Shown).

Davidson (1973), in an extension of the work by Richardson, analytically and numerically tackled the problem of heat transfer from a cylinder in a strong acoustic field in great detail. He obtained a correlation of the dependency of the Nusselt number on both the Prandtl and streaming Reynolds numbers. The correlation, as extracted from the work of Davidson by Gopinath and Mills (1993) for this regime, is of the form

$$Nu = 1.388 Pr^{0.73} R_s^{0.5} \tag{46}$$

By taking Pr = 0.7 for air for these experiments, the equation then becomes

$$Nu = 1.07 R_s^{0.5} \tag{47}$$

The experimental fit in Eq. 45 under predicts by about 13%, but supports this correlation well within the limits of uncertainty.

Figure 17 is a plot of the region in which Eq. 45 is valid, and includes the experimental uncertainty of each data point as derived in Appendix C. It can be observed from this plot that the deviation from the curve fit in this range of values for R_s is well within experimental uncertainty limits.

Although the lower end of the range for "large" R_s in which the predicted solution is valid has been determined to be 130 for the results obtained from these experiments, it is by no means an absolute boundary. Even though the resultant heat transport characteristics deviate significantly below that point in the region where "intermediate" values of R_s are present, there are several factors which could account for part of the discrepancy, especially in the region around $100 < R_s < 130$. These include uncertainty due to equipment limitations and the effects of natural convection and conduction of heat away from the test cylinder.

The effect of natural convection on most of the intermediate values of R_s is negligible, though, as characterized by the very low ratio of the Grashof number to the square of the streaming Reynolds number (except at very low values of R_s). The effect due to conduction is much harder to quantify in so simple a form, though. Conduction can and does occur during the experiment at two separate places where the test cylinder is in contact with

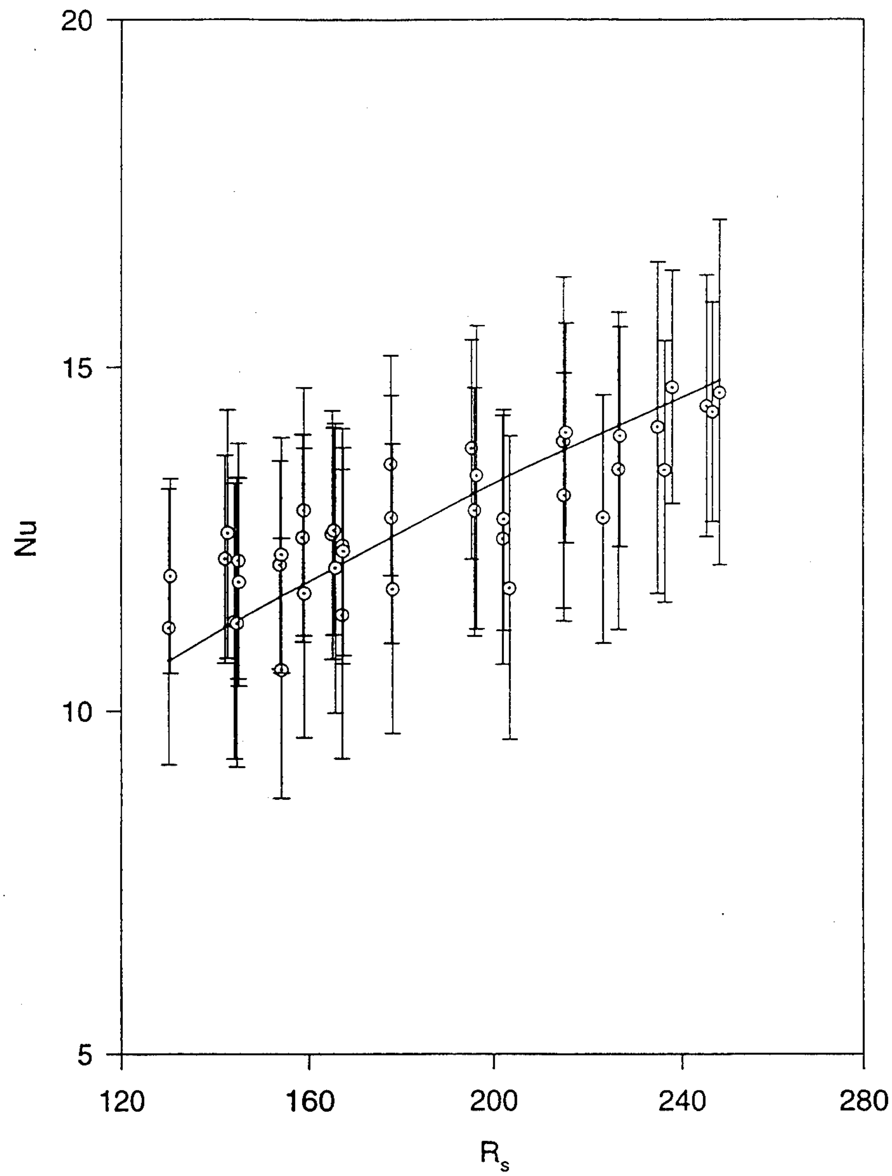

Figure 17. Laminar, Attached Regime for Large R_s with Uncertainty Bars.

other apparatus. The top of the test cylinder is in contact with the "plug" used to hold it in place, while the bottom of the test cylinder is allowed to rest in a small depression on the wall of the plexiglass sound chamber. Realizing, though, that the contact area at both points is very small, and that the thermal resistance of the plug and the plexiglass wall are both relatively high (due to their low thermal conductivity), the heat transport away from the test cylinder can be assumed to be negligible as well.

The uncertainty in the results due to the equipment limitations, though, does have a very significant impact on the results. The calculated value of the Nusselt number has an uncertainty of up to 20% (see Appendix C) depending upon the power being dissipated by the test cylinder. Since the experiment revolves around finding the heat transfer characteristics at specific values of temperature difference between the test cylinder surface and the ambient conditions, correspondingly low power dissipation from the cylinder occurs as the streaming Reynolds number decreases. Therefore, the region of intermediate values of R_s have relatively low electrical heat dissipation, and hence low current values associated with them, dropping to as low as 0.06 amps in some cases. Since the equipment uncertainty for the current reading is of the order of the last digit present, this particular component of the Nusselt number has an uncertainty of nearly 18% by itself and greatly influences the overall uncertainty. Therefore, it may be more accurate to define the lower limit of large R_s values as somewhere between 100 and 130. However, the error due to equipment measurements is not enough to compensate for the disparity between theory and experiment at values much less than 100.

B. SEPARATED FLOW REGIME

The second regime which this experiment encompasses is that in which vortex shedding and other forms of unsteady flow begin to affect the heat transport characteristics. Figure 18 is a plot of the resultant data in this regime as obtained during experimentation in terms of the Nusselt number versus the streaming Reynolds number. A curve fit of the data results in a solution of the form

$$Nu = 0.31 R_s^{0.69} \tag{48}$$

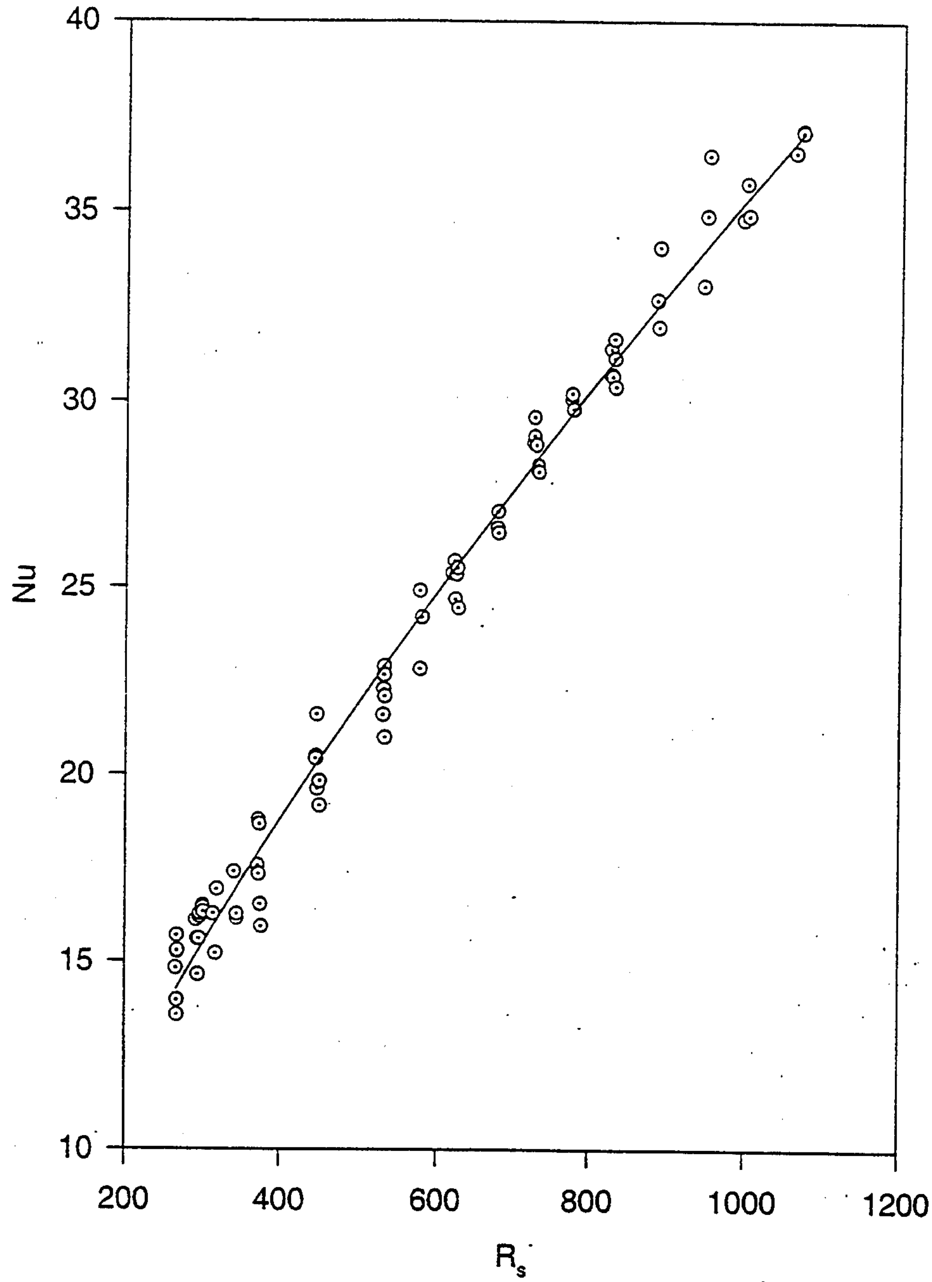

Figure 18. Unstable Regime.

There is no theory for this flow regime with which to compare the results, but it is reasonable to assume that this curve fit is representative of the correct solution. As expected, the unstable flow resulting at higher values of R_s would increase the heat transfer rate from the cylinder, and hence the stronger dependency that the Nusselt number has on the streaming Reynolds number, as opposed to the usual square root dependence.

V. CONCLUSIONS

Experiments were conducted to observe the convective heat transfer rates to an isolated cylinder in an acoustic standing wave. A comparison of the various length scales and other parameters was conducted, and the experimental method stated. During the experiment, the properties of the acoustic field were varied to provide a large base of data which was then analyzed and discussed. Several regimes of interest were investigated and the results presented. Figure 19 is a plot of all data obtained with curve fits for the regimes of interest.

Essentially, heat transfer from a cylinder in a zero-mean oscillatory flow as represented by an acoustic standing wave can be divided into at four separate regimes in which different heat transport mechanisms dominate. For very low values of the streaming Reynolds number, R_s, convective effects due to the acoustic field are negligible and natural convection is then the dominant mode of heat transport. For intermediate values of R_s, there is a stronger dependence on R_s but not yet on the order of $R_s^{0.5}$ since R_s is still not large enough for flow to be of the boundary layer type. Buoyancy effects are comparable in the lower end of this regime, becoming small for larger values of R_s. For much larger values of R_s, past 100 or so, an acoustic streaming flow presents itself in the boundary layer, resulting in a square-root dependency on R_s. Experimentally, the results obtained in this regime closely match the expected theory, and the heat transfer characteristics may be estimated by Eq. 45. Finally, past a critical value of R_s ~240 (which confirms well with theory), an unstable flow with vortex shedding begins to take place at the surface of the cylinder, increasing the dependency on R_s which the overall heat transfer solution has. The heat transfer characteristics in this regime may be estimated from Eq. 48. It is these last two of the above regimes that formed the focus of this study.

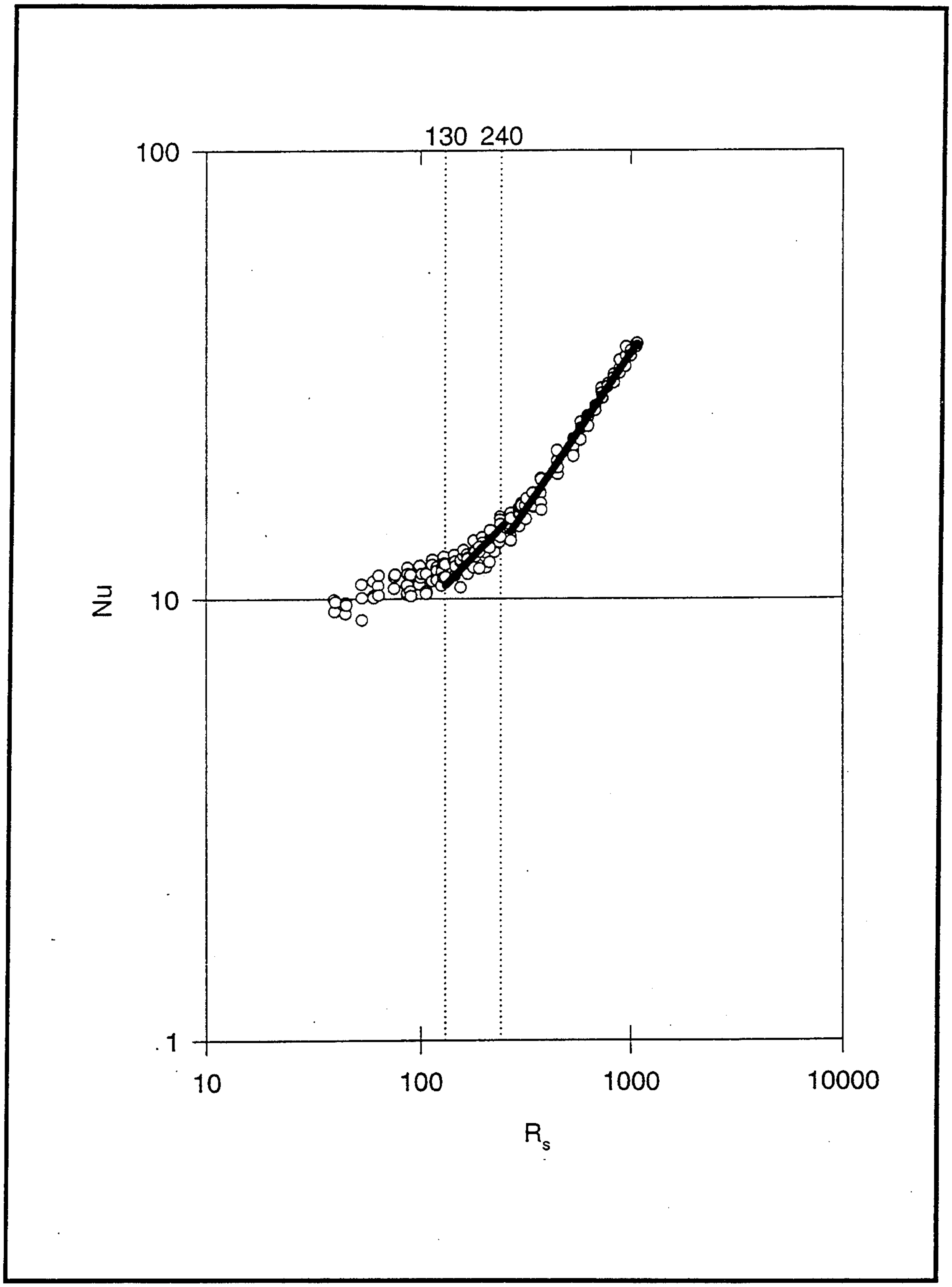

Figure 19. Data Plotted with Curve Fits for the Regimes of Interest.

VI. RECOMMENDATIONS

Several directions for further study may be suggested by the data obtained from this work. One factor which may need further investigation is a study of the effects of varying the aspect ratio of the chamber diameter to the cylinder length to determine whether it was large enough for these experiments. A ratio of 15 was used for this experiment, and was assumed to be large enough to discount flow effects caused by the walls of the chamber, but this number was chosen somewhat arbitrarily and only a detailed experimental study can determine the actual effect.

Another possible source of error which cannot be accurately accounted for concerns itself with the experimental method used. Specifically, the measurement of the ambient temperature within the chamber at the time of each experimental trial. The method used, that of removing the test cylinder from the sound chamber after its temperature has been recorded and the acoustic signal has ceased, then placing a thermocouple through the hole it has just evacuated in the chamber wall, can be improved upon. During the time required while waiting for the thermocouple temperature to peak, the heated air in the sound chamber is rising to the top of the chamber and the accuracy of correlating the thermocouple temperature reading to that of the ambient temperature at the time of the experimental trial is left in doubt. A better method would be to permanently affix the thermocouple in the chamber so that simultaneous measurement of both the cylinder temperature and the ambient temperature can be taken.

Additional research into three different areas of the problem come to mind. First, a test of the effects of placing the test cylinder horizontally in the sound chamber is suggested, although there should be little if any dependency on this orientation since natural convection effects are small for the strong acoustic fields being used. Completely new geometries may also be tested which would mimic actual heat exchanger component shapes expected in a thermoacoustic engine. Finally, additional research using different gases in the sound chamber would provide data on the dependency of the Nusselt number on the Prandtl number.

APPENDIX A. CALIBRATIONS AND CALCULATIONS

Several pieces of the experimental apparatus required some form of calibration, or calculation of a specific parameter, prior to initiating the experiments. The most important equipment items of concern were the "unattached" J-type thermocouples which were to be used for various applications throughout the experiment, as well as the thermocouple which was embedded in the cartridge heater. In addition, an equivalent thermal resistance for the cartridge heater/silicon oil/copper sheath circuit needed to be calculated along with assurances that the linear temperature distribution along the test cylinder was within reasonable limits. An additional study was performed to analyze the heat transfer effects on the test cylinder due only to natural convection.

Three J-type thermocouples were used throughout the experiment and were the first items to be calibrated. Since accurate temperature information was crucial to the reliability of the data obtained through experimentation, the thermocouples were tested to see if any of them showed a tendency to read either higher or lower than the actual temperature (a somewhat common occurrence). The embedded thermocouple in the cartridge heater was also tested for the same reason. All thermocouple leads were attached to the thermocouple reader to be used throughout the experiment to ensure that the entire circuit was tested concurrently.

The unattached thermocouples and the cartridge heater were all placed in an ethyl glycol solution belonging to a Rosemont Model 913A calibration bath. A Rosemont Model 920A commutating bridge, which utilizes a precision temperature probe as its input, provides the reference temperature. The temperature of the bath was then set at varying points between 22° and 48°C, the expected experimental temperatures being well within that range. Table 2 shows the results of the calibration. All thermocouples were found to read within 0.1°C of the reference temperature for all cases. This was well within the possible uncertainty of 0.5°C listed for J-type thermocouples.

Next, Figure 20 shows the thermocouple arrangement which was used to experimentally derive the equivalent thermal resistance and the linear temperature

Reference Temperature (C)	Cartridge Heater (C)	Thermocouple "A" (C)	Thermocouple "B" (C)	Thermocouple "C" (C)	Maximum Deviation (C)
22.83	22.8	22.8	22.8	22.8	< 0.1
23.96	23.9	23.9	23.9	23.9	< 0.1
26.83	26.8	26.8	26.8	26.8	< 0.1
29.63	29.6	29.6	29.6	29.6	< 0.1
32.49	32.5	32.5	32.5	32.5	< 0.1
35.37	35.4	35.4	35.4	35.4	< 0.1
38.04	38.1	38.0	38.0	38.0	< 0.1
40.74	40.8	40.8	40.8	40.8	< 0.1
43.02	43.0	43.0	43.0	43.0	< 0.1
45.68	45.7	45.7	45.7	45.7	< 0.1
48.19	48.2	48.2	48.2	48.2	< 0.1

Table 2: Thermocouple Calibration Data (all values in °C)

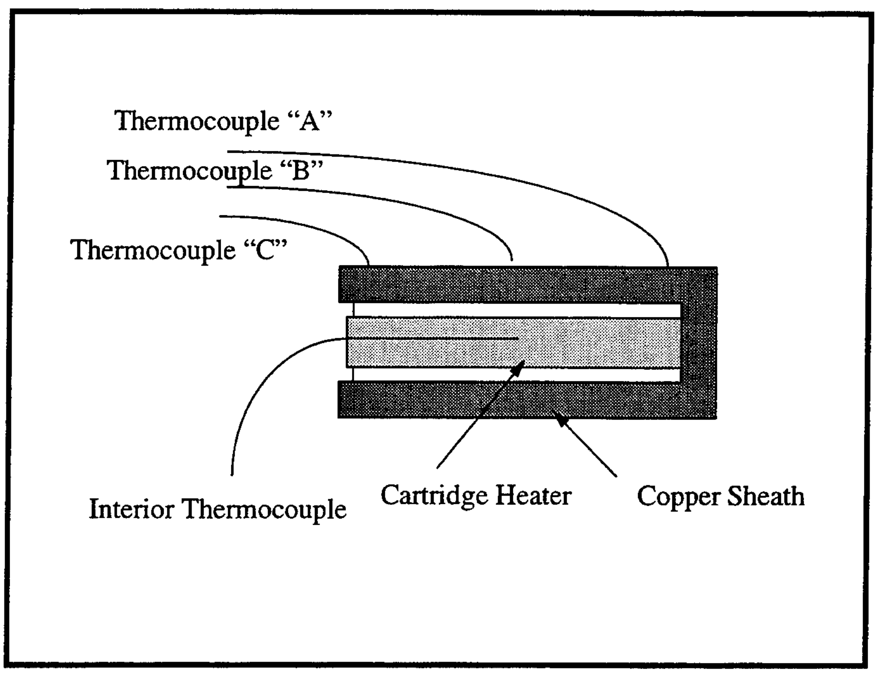

Figure 20. Thermocouple Arrangement for Calibration Tests.

distribution data. The three unattached thermocouples which were previously calibrated were securely placed on the outer surface of the test cylinder using clamps, the test cylinder being already prepared as it normally would for an experimental run. The test cylinder was then suspended horizontally and power was supplied to the cartridge heater. Once all four of the thermocouples reached a steady-state temperature, the temperatures were recorded along with the voltage and current being supplied to the heater. The equivalent thermal resistance was then derived using the equation

$$R_{eq} = \frac{T_c - T_s}{IV} \tag{A.1}$$

Temperatures which were to be comparable with those used during the experiments were obtained in a still air environment. Some additional tests were performed using a fan blowing air across the test cylinder to create a higher heat transfer rate away from the cylinder so that higher power levels to the heater could be reached while staying within the limits of the expected temperature range. An average temperature was then obtained using all three thermocouples, and this value was in turn utilized to derive an equivalent thermal resistance for each test run. The final value of the thermal resistance resulted in averaging the values from each test run, obtaining 1.022 K/W with a maximum deviation of 0.089 K/W. The results are annotated in Table 3.

The same test results were used to determine the change in temperature along the length of the test cylinder. The difference in temperature along the length at the lower power settings demonstrated a fairly even distribution of heat, with a variation of less than 0.6°C. This variation increased as the power to the heater was also increased, as could be expected. For the temperature range in which the experiments were run (again, 26° to 40° C), a maximum variation of 1.6°C occurred, although this was at a very high level of power being supplied to the heater and was not representative of the remaining data.

Current (Amps)	Voltage (Volts)	Power (Watts)	Interior Temp (C)	Thermo-couple "A" (C)	Thermo-couple "B" (C)	Thermo-couple "C" (C)	Average Surf Temp (C)	Equiv Resistance (C)
0.08	8.30	0.664	38.4	37.8	38.1	37.3	37.73	1.009
0.07	7.40	0.518	36.0	35.5	35.5	35.4	35.47	1.023
0.08	8.40	0.672	37.3	36.9	36.8	36.3	36.67	0.938
0.09	9.50	0.855	40.8	40.2	40.1	39.5	39.93	1.018
0.09	10.30	0.927	42.9	42.3	42.0	41.5	41.93	1.046
0.10	10.70	1.070	44.8	44.2	43.7	43.2	43.70	1.028
0.08	9.00	0.720	27.4	26.9	26.6	26.3	26.60	1.111
0.09	10.00	0.900	28.6	27.9	27.8	27.2	27.63	1.078
0.10	11.00	1.100	30.1	29.3	29.2	28.6	29.03	0.973
0.11	12.00	1.320	31.5	30.5	30.5	29.6	30.20	0.985
0.14	15.50	2.170	37.6	35.7	36.0	34.4	35.37	1.028

Table 3: Thermal Resistance and Linear Temperature Distribution Trials

APPENDIX B. UNCERTAINTY ERROR ANALYSIS

In order to obtain a measure of the reliability of the data obtained during experimentation, an uncertainty error analysis was performed for both the Nusselt number and the streaming Reynolds number. The analysis consisted of finding the maximum possible deviation for all components appearing in the equations which define both parameters. Then, in a standard fashion, a root mean square analysis was performed to derive a reasonable overall possible error for each experimental run. The error analysis formulae were themselves incorporated into the "results worksheet" provided in Appendix C so that each data point has an associated possible error derived from the input provided.

The Nusselt number can be derived as shown from Eqs. 37 through 40

$$Nu = \frac{IV}{\pi k l (T_c - IVR_{eq} - T_a)} \tag{B.1}$$

where l is the length of the test cylinder.

Using the manufacturers' recommended equipment error ranges, the maximum uncertainty in each measured component in Eq. B.1 is as follows

$$V = 0.05\%\ reading + 0.02\%\ full\ scale + 1\ digit \tag{B.2}$$

$$I = 0.5\%\ RDG + 1\ digit \tag{B.3}$$

$$T_c = \pm 0.5^o\ C \tag{B.4}$$

$$T_a = \pm 0.5^o\ C \tag{B.5}$$

The maximum uncertainty in the equivalent resistance is obtained from the calibration data in Appendix A as

$$R_{eq} = \pm 0.089 \ K/W \tag{B.6}$$

The analysis for the overall uncertainty itself is structured as follows. For the Nusselt number, the root mean square error is given by

$$\triangle(Nu) = [\sum_i (\frac{\partial Nu}{\partial X_i} \triangle X_i)^2]^{1/2} \tag{B.7}$$

where X_i represents each individual component of Eq. B.1. The $\frac{\partial Nu}{\partial X_i}$ term, as the partial derivative indicates, physically represents the sensitivity of the Nusselt number to the variable X_i, provided all other variables are unchanged. The $\triangle X_i$ represents the uncertainty in the corresponding variable as given in Eqs. B.2 to B.5. For instance, the contribution to the uncertainty due to the voltage measurement is

$$(\triangle Nu)_V = \frac{\partial Nu}{\partial V} \triangle V = Nu \frac{(T_c - T_a)(\triangle V)}{V(T_c - VIR_{eq} - T_a)} \tag{B.8}$$

A value with more significance, though, is the individual fractional uncertainty which takes into account the calculated value of the Nusselt number and can be expressed as a percentage possible error. This is represented by dividing the individual uncertainty by the Nusselt number in the following manner

$$individual \ fractional \ uncertainty = \frac{(\triangle Nu)_V}{Nu} = \frac{(T_c - T_a)(\triangle V)}{V(T_c - VIR_{eq} - T_a)} \tag{B.9}$$

This new term leads directly to the desired method of expressing the possible error in the calculated value of the Nusselt number as an overall fractional uncertainty using a root mean square analysis.

$$\frac{\triangle(Nu)}{Nu} = [\sum_i (\frac{\triangle(Nu)_i}{Nu})^2]^{1/2} \tag{B.10}$$

In a similar fashion, the individual fractional uncertainty of the remaining terms are

as follows

$$\frac{(\Delta Nu)_I}{Nu} = \frac{(T_c - T_a)(\Delta I)}{I(T_c - VIR_{eq} - T_a)} \tag{B.11}$$

$$\frac{(\Delta Nu)_{T_c}}{Nu} = \frac{(\Delta T_c)}{(T_c - VIR_{eq} - T_a)} \tag{B.12}$$

$$\frac{(\Delta Nu)_{T_a}}{Nu} = \frac{(\Delta T_a)}{(T_c - VIR_{eq} - T_a)} \tag{B.13}$$

$$\frac{(\Delta Nu)_{R_{eq}}}{Nu} = \frac{VI(\Delta R_{eq})}{(T_c - VIR_{eq} - T_a)} \tag{B.14}$$

By examining the data results, the largest contributor to the overall error in the Nusselt number is due to the current. This is caused by the small currents being utilized during the experiment, which were as low as 0.05 amps. Since the uncertainty in the current is of the order of 0.01 amps, there can be an error in the calculated Nusselt number of approximately 20% due to the current term alone. One way to lessen the effect that the current term has on the overall error is by decreasing the voltage output of the power supply and hence increasing the current needed to maintain the same power being generated. This capability, though, is not a feature of the equipment being used. It must also be noted that although $\Delta T_{c,a} = \pm 0.5^o\ C$ in Eqs. B.4 and B.5, the calibration of the thermocouples described in Appendix A indicated an error of less than 0.1°C for the temperature range of the experiment. If this is taken into account, the error due to the ambient temperature (T_a) and the center temperature (T_c) terms in Eq. B.1 would diminish by 80%.

The error analysis for the streaming Reynolds number is similar to that just performed for the Nusselt number. Utilizing Eq. 17 and substituting Eqs. 33 and 41 into it, the value of R_s can be shown to be

$$R_s = \frac{R(T_a + 273.15)(V_0/\sqrt{2})^2}{2\pi f\nu\gamma P_m{}^2(0.523)^2} \tag{B.15}$$

Recall that $V_0/\sqrt{2}$ is the multimeter output voltage as derived from the pressure transducer

after being passed through the 100 gain preamplifier. Thus, R_s becomes a function of only the following measured variables: the frequency, the ambient temperature and the pressure transducer output as read on the multimeter, while all additional parameters remain constant. The maximum uncertainty for the thermocouple is the same as previously listed (±0.5°C) while the other two variables have uncertainties provided in the manufacturers' specifications. Calibration data for the pressure transducer used during the experiment indicates an uncertainty equivalent to 0.15% of the percentage of Full Scale Output (FSO) where the FSO is 254 mV. This correlates to a maximum deviation of 2.3 mV after passing through the 100 gain preamplifier. In addition to this, the multimeter which is used to read this voltage has an error of 0.06% reading + 0.03% Range. These combine to give a total microphone voltage output error of

$$Mic = 2.3\ mV + 0.06\%\ reading + 0.03\%\ range \tag{B.16}$$

The uncertainty in the frequency signal from the function generator error is given as 20 ppm, i.e.,

$$f = 20x10^{-6}\ reading \tag{B.17}$$

Again a root mean square analysis was performed in a manner similar to Eq. B.7 to derive the overall fractional uncertainty for the streaming Reynolds number.

$$\frac{\triangle(R_s)}{R_s} = [\sum_i (\frac{\triangle(R_s)_i}{R_s})^2]^{½} \tag{B.18}$$

The individual fractional uncertainties are

$$\frac{(\triangle R_s)_{T_a}}{R_s} = \frac{\triangle T_a}{(T_a + 273.15)} \tag{B.19}$$

$$\frac{(\triangle R_s)_{Mic}}{R_s} = \frac{2(\triangle Mic)}{V_0/\sqrt{2}} \tag{B.20}$$

$$\frac{(\Delta R_s)_f}{R_s} = \frac{\Delta f}{f} \tag{B.21}$$

The largest contribution to the error in the streaming Reynolds number is the error due to the microphone output voltage, specifically, the possible error in the pressure transducer itself. However, the data presented in Appendix C shows that this error is very small and in the range of <2% of the total value.

APPENDIX C. EXPERIMENTAL DATA

The following pages contain the data obtained through experimentation in spreadsheet fashion. All of the relevant parameters are listed, although some constants have been left out due to size constraints.

Experiment Information	Ta (C)	Ttc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h (W/m^2K)	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 583	23.2	29	28.6	5.38	0.06	6.8	582	0.702	183	62.31	181	12.2	0.027	0.351	1.104	1484	944.6	0.005	4.692	1.3244	153.5
L = 73 cm	22.7	29.4	28.9	6.19	0.07	7.13	582	0.703	183	66.29	181	13	0.027	0.352	1.105	1484	944.6	0.005	4.704	1.3263	153.5
PR ~ 1.3	22.9	30.3	29.8	6.86	0.07	7.55	582	0.703	184	63.34	181	12.4	0.027	0.352	1.105	1484	944.6	0.006	4.705	1.3263	153.5
										63.98	181	12.5	0.027	0.352	1.105	1484	944.6	0.005	4.7		
	23.1	34.6	33.7	10.6	0.09	9.53	582	0.703	184	66.38	181	13	0.027	0.352	1.105	1484	944.6	0.009	4.705	1.3263	153.5
	23.2	34.5	33.6	10.4	0.09	9.41	583	0.702	183	66.73	181	13	0.027	0.351	1.102	1486	946.2	0.009	4.694	1.3244	153.5
	23.4	35.4	34.5	11.1	0.09	9.78	583	0.703	184	65.19	181	12.7	0.027	0.351	1.104	1486	946.2	0.009	4.708	1.3263	153.5
										66.1	181	12.9	0.027	0.351	1.104	1485	945.7	0.009	4.702		
	23.5	39.1	38	14.5	0.1	11.24	583	0.703	184	63.94	182	12.5	0.027	0.352	1.104	1486	946.2	0.012	4.708	1.3263	153.5
	23.8	40.8	39.5	15.7	0.11	11.82	583	0.703	184	68.21	182	13.3	0.027	0.352	1.105	1486	946.2	0.013	4.709	1.3263	153.5
	24.1	40	38.8	14.7	0.1	11.51	583	0.702	184	64.27	181	12.6	0.027	0.351	1.104	1486	946.2	0.012	4.696	1.3244	153.5
										65.47	181	12.8	0.027	0.352	1.104	1486	946.2	0.012	4.704		
f ~ 583	23.6	32.2	31.3	7.74	0.09	9.36	583	0.906	305	89.48	301	17.5	0.027	0.453	1.423	1486	946.2	0.002	7.82	1.7092	155.7
L = 73 cm	23.7	31.5	30.8	7.08	0.08	8.77	583	0.905	305	81.43	301	15.9	0.027	0.453	1.422	1486	946.2	0.002	7.803	1.7074	155.7
PR ~ 1.7	23.7	31.8	31.1	7.37	0.08	8.94	583	0.905	305	79.79	301	15.6	0.027	0.453	1.422	1486	946.2	0.002	7.803	1.7074	155.7
										83.57	301	16.3	0.027	0.453	1.423	1486	946.2	0.002	7.808		
	24	35.5	34.4	10.4	0.1	10.75	583	0.902	303	84.96	299	16.6	0.027	0.451	1.418	1486	946.2	0.003	7.752	1.7017	155.7
	24.3	36.1	35	10.7	0.1	10.93	584	0.903	303	84.11	300	16.4	0.027	0.451	1.418	1489	947.9	0.003	7.773	1.7036	155.7
	24.5	36.2	35.1	10.6	0.1	10.86	584	0.903	304	84.3	300	16.5	0.027	0.452	1.418	1489	947.9	0.003	7.774	1.7036	155.7
										84.46	300	16.5	0.027	0.451	1.418	1488	947.3	0.003	7.767		
	24.2	39.8	38.4	14.2	0.11	12.7	584	0.904	304	81.04	301	15.8	0.027	0.452	1.419	1489	947.9	0.004	7.79	1.7055	155.7
	24.5	41.2	39.6	15.1	0.12	13.15	584	0.904	304	85.98	301	16.8	0.027	0.452	1.42	1489	947.9	0.004	7.791	1.7055	155.7
	24.7	41.3	39.7	15	0.12	13	584	0.905	305	85.46	301	16.7	0.027	0.453	1.422	1489	947.9	0.004	7.809	1.7074	155.7
										84.16	301	16.4	0.027	0.452	1.42	1489	947.9	0.004	7.797		
f ~ 583	22.9	30.6	29.7	6.83	0.09	9.46	582	1.104	453	102.5	447	20	0.027	0.552	1.735	1484	944.6	9E-04	11.6	2.0828	157.5
L = 73 cm	23.2	31.6	30.7	7.49	0.09	9.92	582	1.099	449	98.02	443	19.2	0.027	0.55	1.728	1484	944.6	0.001	11.5	2.0733	157.4
PR ~ 2.1	23.4	31.5	30.6	7.2	0.09	9.8	583	1.107	455	100.7	450	19.7	0.027	0.553	1.739	1486	946.2	1E-03	11.67	2.0884	157.5
										100.4	447	19.6	0.027	0.552	1.734	1485	945.2	1E-03	11.59		
	23.7	36.2	34.8	11.1	0.11	12.16	583	1.106	455	98.77	449	19.3	0.027	0.553	1.738	1486	946.2	0.001	11.65	2.0866	157.5
	23.9	35.7	34.4	10.5	0.11	11.86	583	1.107	456	102.5	450	20	0.027	0.554	1.74	1486	946.2	0.001	11.68	2.0884	157.5
	23.9	35.5	34.2	10.3	0.11	11.73	583	1.107	456	103.2	450	20.2	0.027	0.554	1.74	1486	946.2	0.001	11.68	2.0884	157.5
										101.6	450	19.8	0.027	0.554	1.739	1486	946.2	0.001	11.67		
	24.2	39.9	38.2	14	0.12	13.66	583	1.103	453	96.08	447	18.8	0.027	0.552	1.735	1486	946.2	0.002	11.59	2.0809	157.5
	24.3	40.3	38.6	14.3	0.12	13.89	584	1.107	456	95.84	451	18.7	0.027	0.553	1.738	1489	947.9	0.002	11.68	2.0884	157.5
	24.5	41.3	39.4	14.9	0.13	14.28	584	1.107	456	102.4	451	20	0.027	0.554	1.739	1489	947.9	0.002	11.68	2.0884	157.5
										98.11	450	19.2	0.027	0.553	1.737	1488	947.3	0.002	11.65		

Experimental Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	I uncert	overall Rs uncert
f ~ 583	0.2123	18.493	9.2866	9.2866	0.6972	22.693	0.1687	0.9402	0.002	0.9552
L = 73 cm	0.2059	16.001	8.0759	8.0759	0.7416	19.674	0.169	0.9388	0.002	0.9539
PR ~ 1.3	0.1968	15.947	7.2873	7.2873	0.7086	19.001	0.1689	0.9388	0.002	0.9539
						20.456				0.9543
	0.1677	12.567	4.7056	4.7056	0.7426	14.24	0.1688	0.9388	0.002	0.9539
	0.1692	12.572	4.7908	4.7908	0.7465	14.302	0.1687	0.9402	0.002	0.9552
	0.1646	12.549	4.5034	4.5034	0.7294	14.093	0.1686	0.9388	0.002	0.9539
						14.212				0.9543
	0.15	11.332	3.4592	3.4592	0.7154	12.365	0.1685	0.9388	0.002	0.9538
	0.146	10.402	3.1899	3.1899	0.7631	11.365	0.1684	0.9388	0.002	0.9538
	0.1478	11.337	3.3952	3.3952	0.719	12.333	0.1682	0.9402	0.002	0.9551
						12.021				0.9543
f ~ 583	0.1742	12.899	6.4589	6.4589	1.0011	15.838	0.1685	0.7285	0.002	0.7477
L = 73 cm	0.1806	14.312	7.0574	7.0574	0.9111	17.473	0.1684	0.7293	0.002	0.7485
PR ~ 1.7	0.1779	14.286	6.7834	6.7834	0.8927	17.232	0.1684	0.7293	0.002	0.7485
						16.848				0.7482
	0.1581	11.606	4.8058	4.8058	0.9506	13.484	0.1683	0.7317	0.002	0.7508
	0.1562	11.595	4.6791	4.6791	0.941	13.384	0.1681	0.7309	0.002	0.75
	0.1569	11.597	4.7201	4.7201	0.9432	13.415	0.168	0.7309	0.002	0.75
						13.428				0.7502
	0.1417	10.554	3.5271	3.5271	0.9066	11.71	0.1682	0.7301	0.002	0.7492
	0.1395	9.7749	3.3131	3.3131	0.962	10.883	0.168	0.7301	0.002	0.7492
	0.1404	9.7692	3.3312	3.3312	0.9562	10.889	0.1679	0.7293	0.002	0.7484
						11.161				0.7489
f ~ 583	0.1755	13.086	7.3184	7.3184	1.1465	16.724	0.1689	0.5978	0.002	0.6212
L = 73 cm	0.1691	13.022	6.6756	6.6756	1.0966	16.122	0.1687	0.6005	0.002	0.6238
PR ~ 2.1	0.171	13.061	6.9436	6.9436	1.1269	16.38	0.1686	0.5962	0.002	0.6196
						16.409				0.6215
	0.1484	10.765	4.4897	4.4897	1.105	12.548	0.1684	0.5967	0.002	0.6201
	0.1514	10.809	4.7755	4.7755	1.1463	12.798	0.1683	0.5962	0.002	0.6195
	0.1525	10.817	4.8616	4.8616	1.1542	12.87	0.1683	0.5962	0.002	0.6195
						12.739				0.6197
	0.1379	9.8854	3.564	3.564	1.075	11.149	0.1682	0.5984	0.002	0.6215
	0.1365	9.8828	3.4963	3.4963	1.0723	11.103	0.1681	0.5962	0.002	0.6195
	0.1353	9.2322	3.354	3.354	1.1456	10.443	0.168	0.5962	0.002	0.6194
						10.899				0.6201

Experiment Information	Ta (C)	Ttc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 584	24	31.6	30.5	6.52	0.1	10.61	584	1.305	633	133.8	626	26.2	0.027	0.652	2.048	1489	947.9	4E-04	16.23	2.462	158.9
L = 73 cm	24.1	32.2	31.1	6.99	0.1	10.85	584	1.303	631	127.6	624	24.9	0.027	0.651	2.045	1489	947.9	5E-04	16.18	2.4582	158.9
PR ~ 2.5	24.3	32.1	31	6.71	0.1	10.66	584	1.304	633	130.6	625	25.5	0.027	0.652	2.048	1489	947.9	4E-04	16.21	2.4601	158.9
										130.7	625	25.5	0.027	0.652	2.047	1489	947.9	5E-04	16.21		
	24.5	35.9	34.3	9.81	0.12	12.97	584	1.302	631	130.4	624	25.5	0.027	0.651	2.045	1489	947.9	7E-04	16.16	2.4563	158.9
	24.7	36.8	35.2	10.5	0.12	13.24	584	1.3	630	124.7	622	24.4	0.027	0.65	2.043	1489	947.9	7E-04	16.11	2.4526	158.9
	24.8	37.1	35.5	10.7	0.12	13.4	584	1.3	630	124	622	24.2	0.027	0.65	2.043	1489	947.9	7E-04	16.11	2.4526	158.9
										126.4	622	24.7	0.027	0.651	2.044	1489	947.9	7E-04	16.13		
	25.1	40.7	38.5	13.4	0.14	15.27	585	1.305	634	131	627	25.6	0.027	0.652	2.048	1491	949.5	9E-04	16.25	2.462	158.9
	25.2	40.4	38.4	13.2	0.13	15.04	585	1.303	632	121.7	626	23.8	0.027	0.651	2.046	1491	949.5	9E-04	16.2	2.4582	158.9
	25.3	40.4	38.4	13.1	0.13	15.04	585	1.304	634	122.7	627	24	0.027	0.652	2.048	1491	949.5	8E-04	16.22	2.4601	158.9
										125.1	627	24.4	0.027	0.652	2.047	1491	949.5	9E-04	16.22		
f ~ 584	24.7	32.6	31.3	6.56	0.11	11.93	585	1.501	838	164.4	830	32.1	0.027	0.749	2.355	1491	949.5	2E-04	21.49	2.8318	160.1
L = 73 cm	24.7	31.8	30.7	5.96	0.1	11.23	585	1.5	837	155.1	829	30.3	0.027	0.749	2.353	1491	949.5	2E-04	21.46	2.8299	160.1
PR ~ 2.8	25.1	32.8	31.5	6.38	0.11	11.76	585	1.501	839	166.7	830	32.6	0.027	0.75	2.356	1491	949.5	2E-04	21.49	2.8318	160.1
										162.1	830	31.7	0.027	0.749	2.355	1491	949.5	2E-04	21.48		
	25.1	37.1	35.2	10.1	0.13	14.53	585	1.5	838	154.2	829	30.1	0.027	0.749	2.355	1491	949.5	4E-04	21.46	2.8299	160.1
	25.4	36.8	34.9	9.5	0.13	14.31	585	1.494	832	161	822	31.4	0.027	0.747	2.346	1491	949.5	4E-04	21.3	2.8185	160.1
	25.4	37.4	35.4	10	0.13	14.74	585	1.497	835	156.8	826	30.6	0.027	0.748	2.351	1491	949.5	4E-04	21.38	2.8242	160.1
										157.3	826	30.7	0.027	0.748	2.351	1491	949.5	4E-04	21.38		
	25.7	39.6	37.3	11.6	0.14	15.84	586	1.503	841	156.7	833	30.6	0.027	0.75	2.358	1494	951.1	4E-04	21.56	2.8355	160.1
	25.9	40.7	38.4	12.5	0.14	16.3	586	1.5	839	150.4	830	29.4	0.027	0.749	2.354	1494	951.1	4E-04	21.48	2.8299	160.1
	25.9	41.4	38.8	12.9	0.15	16.76	586	1.5	839	159.8	830	31.2	0.027	0.749	2.354	1494	951.1	5E-04	21.48	2.8299	160.1
										155.6	831	30.4	0.027	0.75	2.355	1494	951.1	4E-04	21.51		
f ~ 584	23.2	30.8	30.1	6.93	0.08	8.2	583	0.804	240	77.83	237	15.2	0.027	0.402	1.262	1486	946.2	0.003	6.157	1.5168	154.7
L = 73 cm	23.3	31.1	30.4	7.11	0.08	8.52	583	0.804	240	78.88	237	15.4	0.027	0.402	1.263	1486	946.2	0.003	6.157	1.5168	154.7
PR ~ 1.5	23.3	31.4	30.7	7.41	0.08	8.52	583	0.804	240	75.69	237	14.8	0.027	0.402	1.263	1486	946.2	0.004	6.157	1.5168	154.7
										77.47	237	15.1	0.027	0.402	1.262	1486	946.2	0.003	6.157		
	23.6	35.7	34.6	11	0.1	10.59	583	0.804	240	79.02	237	15.4	0.027	0.402	1.263	1486	946.2	0.005	6.158	1.5168	154.7
	23.7	36.1	35	11.3	0.1	10.78	583	0.803	240	78.44	237	15.3	0.027	0.402	1.262	1486	946.2	0.005	6.143	1.5149	154.7
	23.9	36.4	35.3	11.4	0.1	10.91	583	0.804	241	78.78	237	15.4	0.027	0.402	1.264	1486	946.2	0.005	6.159	1.5168	154.7
										78.75	237	15.4	0.027	0.402	1.263	1486	946.2	0.005	6.153		
	23.9	39.3	37.9	14	0.11	12.21	583	0.803	240	78.71	237	15.4	0.027	0.402	1.262	1486	946.2	0.007	6.144	1.5149	154.7
	24.1	40.1	38.7	14.6	0.11	12.41	583	0.803	240	76.84	237	15	0.027	0.402	1.263	1486	946.2	0.007	6.144	1.5149	154.7
	24.1	39.9	38.5	14.4	0.11	12.31	583	0.803	240	77.22	237	15.1	0.027	0.402	1.263	1486	946.2	0.007	6.144	1.5149	154.7
										77.59	237	15.2	0.027	0.402	1.263	1486	946.2	0.007	6.144		

Experiment Information	V uncert	I uncert	Ta uncert	To uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 584	0.1682	12.242	7.6705	7.6705	1.4975	16.426	0.1683	0.5057	0.002	0.533
L = 73 cm	0.1646	12.16	7.149	7.149	1.4272	15.879	0.1682	0.5065	0.002	0.5337
PR ~ 2.5	0.1671	12.2	7.4478	7.4478	1.4608	16.184	0.1681	0.5061	0.002	0.5333
						16.163				0.5334
	0.1476	10.261	5.095	5.095	1.4591	12.624	0.168	0.5069	0.002	0.534
	0.1449	10.198	4.7708	4.7708	1.3947	12.308	0.1679	0.5077	0.002	0.5347
	0.1438	10.191	4.6901	4.6901	1.3877	12.24	0.1678	0.5077	0.002	0.5347
						12.391				0.5345
	0.1342	8.8839	3.7256	3.7256	1.4655	10.433	0.1676	0.5057	0.002	0.5328
	0.1341	9.4286	3.7859	3.7859	1.362	10.929	0.1676	0.5065	0.002	0.5335
	0.1342	9.438	3.8148	3.8148	1.3724	10.958	0.1675	0.5061	0.002	0.5331
						10.773				0.5332
f ~ 584	0.1611	11.546	7.6193	7.6193	1.8398	15.901	0.1679	0.4397	0.002	0.4707
L = 73 cm	0.1658	12.518	8.396	8.396	1.7349	17.342	0.1679	0.44	0.002	0.4709
PR ~ 2.8	0.1629	11.573	7.8353	7.8353	1.865	16.131	0.1676	0.4397	0.002	0.4706
						16.458				0.4707
	0.1415	9.7581	4.963	4.963	1.7249	12.144	0.1676	0.44	0.002	0.4709
	0.1438	9.827	5.2611	5.2611	1.8009	12.458	0.1675	0.4418	0.002	0.4725
	0.1408	9.7851	4.9768	4.9768	1.7547	12.181	0.1675	0.4409	0.002	0.4716
						12.261				0.4716
	0.1351	9.1272	4.2957	4.2957	1.7528	11.104	0.1673	0.4391	0.002	0.4699
	0.1321	9.0681	4.0084	4.0084	1.6831	10.827	0.1672	0.44	0.002	0.4707
	0.1314	8.5863	3.8648	3.8648	1.7878	10.335	0.1672	0.44	0.002	0.4707
						10.755				0.4704
f ~ 584	0.1885	14.254	7.2137	7.2137	0.8707	17.551	0.1687	0.8209	0.002	0.8381
L = 73 cm	0.1837	14.271	7.0371	7.0371	0.8826	17.422	0.1687	0.8209	0.002	0.838
PR ~ 1.5	0.1831	14.22	6.752	6.752	0.8468	17.15	0.1687	0.8209	0.002	0.838
						17.374				0.838
	0.1586	11.529	4.537	4.537	0.8841	13.224	0.1685	0.8209	0.002	0.838
	0.1566	11.521	4.4243	4.4243	0.8776	13.141	0.1684	0.8219	0.002	0.839
	0.1555	11.525	4.3906	4.3906	0.8814	13.122	0.1683	0.8209	0.002	0.838
						13.162				0.8383
	0.1448	10.527	3.5636	3.5636	0.8807	11.705	0.1683	0.8219	0.002	0.839
	0.143	10.504	3.4227	3.4227	0.8597	11.599	0.1682	0.8219	0.002	0.839
	0.1438	10.509	3.4675	3.4675	0.8639	11.63	0.1682	0.8219	0.002	0.839
						11.645				0.839

Experiment Information	Ta (C)	Tt/c (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 584	23.8	30.8	30.1	6.27	0.08	8.97	583	1.006	376	94.13	372	18.4	0.027	0.503	1.581	1486	946.2	0.001	9.642	1.8979	156.7
L = 73 cm	23.8	31.8	30.9	7.13	0.09	9.46	583	1.006	376	98.16	372	19.2	0.027	0.503	1.581	1486	946.2	0.001	9.642	1.8979	156.7
PR ~ 1.9	23.9	32.1	31.2	7.33	0.09	9.53	583	1.006	377	96.28	372	18.8	0.027	0.503	1.581	1486	946.2	0.001	9.642	1.8979	156.7
										96.19	372	18.8	0.027	0.503	1.581	1486	946.2	0.001	9.642		
	24.1	35.6	34.5	10.4	0.1	11.19	583	1.005	376	88.82	371	17.4	0.027	0.503	1.58	1486	946.2	0.002	9.624	1.896	156.6
	24.2	35.8	34.6	10.4	0.1	11.32	584	1.006	376	89.11	372	17.4	0.027	0.503	1.579	1489	947.9	0.002	9.647	1.8979	156.7
	24.3	36.2	35	10.7	0.1	11.52	584	1.007	377	88.32	373	17.3	0.027	0.503	1.581	1489	947.9	0.002	9.667	1.8998	156.7
										88.75	372	17.3	0.027	0.503	1.58	1488	947.3	0.002	9.646		
	24.3	39.2	37.6	13.3	0.12	13.02	584	1.007	377	96.55	373	18.9	0.027	0.503	1.581	1489	947.9	0.003	9.667	1.8998	156.7
	24.4	39.9	38.3	13.9	0.12	13.41	584	1.004	375	95.48	371	18.7	0.027	0.502	1.577	1489	947.9	0.003	9.61	1.8941	156.6
	24.4	40.3	38.6	14.2	0.12	13.64	584	1.01	380	94.58	375	18.5	0.027	0.505	1.586	1489	947.9	0.003	9.725	1.9054	156.7
										95.53	373	18.7	0.027	0.503	1.581	1489	947.9	0.003	9.667		
f ~ 584	23.6	31.4	30.5	6.88	0.09	10.05	583	1.202	537	108.1	531	21.1	0.027	0.601	1.889	1486	946.2	7E-04	13.76	2.2677	158.2
L = 73 cm	23.6	31.7	30.8	7.16	0.09	10.3	583	1.202	537	106.5	531	20.8	0.027	0.601	1.889	1486	946.2	7E-04	13.76	2.2677	158.2
PR ~ 2.3	23.8	32.3	31.2	7.42	0.1	10.55	583	1.2	536	116.8	529	22.8	0.027	0.6	1.886	1486	946.2	7E-04	13.72	2.2639	158.2
										110.5	530	21.6	0.027	0.601	1.888	1486	946.2	7E-04	13.75		
	24	35.9	34.5	10.5	0.11	12.51	584	1.203	538	107.8	532	21.1	0.027	0.601	1.888	1489	947.9	1E-03	13.79	2.2696	158.2
	24.2	36.3	34.9	10.7	0.11	12.73	584	1.202	537	107.9	531	21.1	0.027	0.601	1.887	1489	947.9	1E-03	13.77	2.2677	158.2
	24.2	36.3	34.9	10.7	0.11	12.6	584	1.204	539	106.6	533	20.8	0.027	0.602	1.89	1489	947.9	1E-03	13.82	2.2714	158.2
										107.4	532	21	0.027	0.601	1.889	1489	947.9	1E-03	13.79		
	24.5	40	38.1	13.6	0.13	14.49	584	1.204	540	114.1	533	22.3	0.027	0.602	1.891	1489	947.9	0.001	13.82	2.2714	158.2
	24.6	40.4	38.5	13.9	0.13	14.66	584	1.203	539	113.1	532	22.1	0.027	0.602	1.89	1489	947.9	0.001	13.8	2.2696	158.2
	24.7	40.8	38.8	14.1	0.13	14.82	584	1.201	537	112.1	531	21.9	0.027	0.601	1.887	1489	947.9	0.001	13.75	2.2658	158.2
										113.1	532	22.1	0.027	0.601	1.889	1489	947.9	0.001	13.79		
f ~ 584	24.2	32.8	31.4	7.24	0.11	12.12	584	1.409	738	151.4	730	29.6	0.027	0.704	2.212	1489	947.9	4E-04	18.92	2.6582	159.6
L = 73 cm	24.3	32.9	31.6	7.26	0.11	11.97	584	1.405	734	149.2	726	29.1	0.027	0.702	2.206	1489	947.9	4E-04	18.82	2.6506	159.6
PR ~ 2.7	24.3	33.5	32.1	7.82	0.11	12.31	584	1.408	737	142.4	729	27.8	0.027	0.704	2.211	1489	947.9	4E-04	18.9	2.6563	159.6
										147.7	729	28.9	0.027	0.703	2.21	1489	947.9	4E-04	18.88		
	24.4	36.7	34.8	10.4	0.13	14.34	585	1.41	739	147.4	732	28.8	0.027	0.704	2.211	1491	949.5	5E-04	18.96	2.6601	159.6
	24.5	36.3	34.6	10.1	0.12	13.94	585	1.409	738	136.3	731	26.6	0.027	0.703	2.21	1491	949.5	5E-04	18.93	2.6582	159.6
	24.7	36.8	34.9	10.2	0.13	14.17	585	1.409	738	148.2	731	29	0.027	0.704	2.21	1491	949.5	5E-04	18.93	2.6582	159.6
										143.9	731	28.1	0.027	0.704	2.21	1491	949.5	5E-04	18.94		
	25	39.9	37.6	12.6	0.14	15.86	585	1.408	738	144.5	730	28.2	0.027	0.703	2.21	1491	949.5	6E-04	18.91	2.6563	159.6
	25.1	40.3	38	12.9	0.14	16.13	585	1.407	737	144	729	28.1	0.027	0.703	2.209	1491	949.5	6E-04	18.89	2.6544	159.6
	25.2	40.1	37.8	12.6	0.14	16	585	1.408	738	146	730	28.5	0.027	0.704	2.211	1491	949.5	6E-04	18.91	2.6563	159.6
										144.8	730	28.3	0.027	0.703	2.21	1491	949.5	6E-04	18.9		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 584	0.1803	14.517	7.9764	7.9764	1.0532	18.416	0.1684	0.6561	0.002	0.6773
L = 73 cm	0.1747	13.024	7.0105	7.0105	1.0983	16.406	0.1684	0.6561	0.002	0.6773
PR ~ 1.9	0.1734	12.997	6.8253	6.8253	1.0771	16.226	0.1683	0.6561	0.002	0.6773
						17.016				0.6773
	0.1547	11.656	4.8266	4.8266	0.9938	13.545	0.1682	0.6567	0.002	0.6779
	0.1536	11.66	4.7865	4.7865	0.997	13.52	0.1682	0.6561	0.002	0.6773
	0.1518	11.65	4.6617	4.6617	0.9881	13.423	0.1681	0.6554	0.002	0.6766
						13.496				0.6773
	0.142	9.8905	3.7573	3.7573	1.0802	11.28	0.1681	0.6554	0.002	0.6766
	0.1393	9.8788	3.6076	3.6076	1.0682	11.171	0.168	0.6574	0.002	0.6785
	0.1378	9.869	3.5133	3.5133	1.0581	11.101	0.168	0.6535	0.002	0.6747
						11.184				0.6766
f ~ 584	0.1695	13.168	7.2696	7.2696	1.2099	16.75	0.1685	0.5491	0.002	0.5744
L = 73 cm	0.1665	13.145	6.9881	6.9881	1.1919	16.489	0.1685	0.5491	0.002	0.5744
PR ~ 2.3	0.1658	12.021	6.7344	6.7344	1.3073	15.393	0.1684	0.55	0.002	0.5752
						16.211				0.5746
	0.1473	10.873	4.7632	4.7632	1.206	12.848	0.1683	0.5486	0.002	0.5739
	0.1457	10.874	4.6849	4.6849	1.2071	12.791	0.1682	0.5491	0.002	0.5743
	0.1465	10.859	4.6785	4.6785	1.1931	12.772	0.1682	0.5482	0.002	0.5734
						12.804				0.5738
	0.1358	9.3507	3.6819	3.6819	1.2762	10.779	0.168	0.5482	0.002	0.5733
	0.1348	9.3408	3.6082	3.6082	1.2653	10.72	0.1679	0.5486	0.002	0.5738
	0.1338	9.3305	3.537	3.537	1.2539	10.662	0.1679	0.5495	0.002	0.5746
						10.72				0.5739
f ~ 584	0.1574	11.391	6.9051	6.9051	1.6939	15.1	0.1682	0.4684	0.002	0.4977
L = 73 cm	0.1582	11.365	6.8891	6.8891	1.6691	15.063	0.1681	0.4698	0.002	0.4989
PR ~ 2.7	0.1544	11.284	6.3941	6.3941	1.5931	14.548	0.1681	0.4688	0.002	0.498
						14.904				0.4982
	0.1416	9.6893	4.8078	4.8078	1.6491	11.952	0.168	0.4681	0.002	0.4973
	0.1423	10.325	4.953	4.953	1.5245	12.571	0.168	0.4684	0.002	0.4976
	0.1427	9.6972	4.8913	4.8913	1.6579	12.027	0.1679	0.4684	0.002	0.4976
						12.183				0.4975
	0.1333	9.0118	3.9568	3.9568	1.6165	10.731	0.1677	0.4688	0.002	0.4978
	0.132	9.0069	3.8766	3.8766	1.6107	10.667	0.1676	0.4691	0.002	0.4981
	0.1329	9.0261	3.963	3.963	1.6334	10.75	0.1676	0.4688	0.002	0.4978
						10.716				0.4979

Experiment Information	Ta (C)	Tto (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs Λ	PR %	SPL (dB)
f ~ 1055	22.8	30.7	30.2	7.38	0.07	7.31	1055	0.702	101	57.03	99.9	11.1	0.049	0.194	0.609	2690	1712	0.021	1.926	1.3244	153.5
L = 73 cm	23.1	31.1	30.6	7.47	0.07	7.49	1055	0.702	101	57.75	99.8	11.3	0.049	0.194	0.609	2690	1712	0.021	1.925	1.3244	153.5
PR ~ 1.3	23	31.4	30.8	7.85	0.07	7.73	1056	0.706	102	56.69	101	11.1	0.049	0.195	0.612	2692	1714	0.021	1.95	1.3319	153.6
										57.16	100	11.2	0.049	0.194	0.61	2691	1713	0.021	1.933		
	23.1	35.1	34.3	11.2	0.08	9.3	1056	0.707	102	54.42	101	10.6	0.049	0.195	0.613	2692	1714	0.03	1.955	1.3338	153.6
	23.2	35.6	34.7	11.5	0.09	9.45	1056	0.709	103	60.64	102	11.8	0.049	0.196	0.615	2692	1714	0.03	1.966	1.3376	153.6
	23.3	36	35.1	11.8	0.09	9.53	1056	0.708	103	59.64	102	11.7	0.049	0.195	0.614	2692	1714	0.031	1.96	1.3357	153.6
										58.23	102	11.4	0.049	0.195	0.614	2692	1714	0.031	1.96		
	23.6	40.9	39.7	16.1	0.1	11.48	1056	0.708	103	58.53	102	11.4	0.049	0.195	0.614	2692	1714	0.042	1.959	1.3357	153.6
	23.7	40.6	39.5	15.8	0.1	11.09	1056	0.707	103	57.83	101	11.3	0.049	0.195	0.613	2692	1714	0.041	1.953	1.3338	153.6
	23.8	40.7	39.6	15.8	0.1	11.21	1056	0.705	102	58.5	101	11.4	0.049	0.195	0.612	2692	1714	0.041	1.941	1.33	153.6
										58.28	101	11.4	0.049	0.195	0.613	2692	1714	0.042	1.951		
f ~ 1055	23.7	31.8	31.3	7.57	0.07	7.47	1056	0.801	132	56.82	130	11.1	0.049	0.221	0.695	2692	1714	0.012	2.507	1.5111	154.7
L = 73 cm	23.4	31.7	31.1	7.75	0.07	7.74	1056	0.803	132	57.5	131	11.2	0.049	0.222	0.696	2692	1714	0.012	2.521	1.5149	154.7
PR ~ 1.5	23.5	31.9	31.3	7.84	0.07	7.87	1056	0.803	132	57.79	131	11.3	0.049	0.222	0.696	2692	1714	0.012	2.52	1.5149	154.7
										57.37	131	11.2	0.049	0.222	0.696	2692	1714	0.012	2.516		
	23.7	36.4	35.5	11.8	0.09	9.95	1056	0.8	131	62.47	130	12.2	0.049	0.221	0.694	2692	1714	0.019	2.5	1.5093	154.7
	23.7	36.3	35.4	11.7	0.09	9.7	1056	0.799	131	61.3	129	12	0.049	0.221	0.693	2692	1714	0.019	2.494	1.5074	154.7
	23.7	36.1	35.2	11.5	0.09	9.49	1057	0.799	131	60.92	130	11.9	0.049	0.22	0.693	2695	1716	0.018	2.498	1.5074	154.7
										61.56	130	12	0.049	0.221	0.693	2693	1714	0.019	2.497		
	24	39.7	38.6	14.6	0.1	10.91	1057	0.802	132	61.5	131	12	0.049	0.221	0.695	2695	1716	0.023	2.515	1.513	154.7
	24	40.4	39.3	15.3	0.1	11.28	1057	0.804	133	60.82	131	11.9	0.049	0.222	0.697	2695	1716	0.023	2.528	1.5168	154.7
	24	40.1	39	15	0.1	11.15	1057	0.803	132	61.27	131	12	0.049	0.222	0.696	2695	1716	0.023	2.522	1.5149	154.7
										61.2	131	12	0.049	0.222	0.696	2695	1716	0.023	2.522		
f ~ 1055	23.9	32.7	32	8.13	0.08	8.22	1057	0.902	167	66.52	165	13	0.049	0.249	0.782	2695	1716	0.008	3.182	1.7017	155.7
L = 73 cm	23.8	31.8	31.3	7.45	0.07	7.7	1057	0.903	167	59.49	166	11.6	0.049	0.249	0.783	2695	1716	0.007	3.19	1.7036	155.7
PR ~ 1.7	23.8	32	31.4	7.64	0.07	7.88	1057	0.903	167	59.39	166	11.6	0.049	0.249	0.783	2695	1716	0.007	3.19	1.7036	155.7
										61.8	165	12.1	0.049	0.249	0.783	2695	1716	0.008	3.187		
	24	35.8	34.9	10.9	0.09	9.4	1057	0.901	167	63.6	165	12.4	0.049	0.249	0.781	2695	1716	0.011	3.175	1.6998	155.7
	24.1	36	35.1	11	0.09	9.69	1057	0.901	167	65.13	165	12.7	0.049	0.249	0.781	2695	1716	0.011	3.174	1.6998	155.7
	24.1	36.5	35.6	11.5	0.09	9.96	1057	0.901	167	64.17	165	12.5	0.049	0.249	0.781	2695	1716	0.011	3.174	1.6998	155.7
										64.3	165	12.6	0.049	0.249	0.781	2695	1716	0.011	3.174		
	24.4	41.5	40.2	15.8	0.11	11.8	1057	0.9	167	67.65	164	13.2	0.049	0.249	0.781	2695	1716	0.015	3.165	1.6979	155.7
	24.5	40.2	39.1	14.6	0.1	11.16	1058	0.903	168	63.02	166	12.3	0.049	0.249	0.783	2697	1717	0.014	3.191	1.7036	155.7
	24.5	40.6	39.4	14.9	0.1	11.44	1058	0.902	167	62.99	165	12.3	0.049	0.249	0.782	2697	1717	0.014	3.184	1.7017	155.7
										64.55	165	12.6	0.049	0.249	0.782	2696	1717	0.014	3.18		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1055	0.2	15.831	6.7765	6.7765	0.638	18.518	0.1689	0.9402	0.002	0.9552
L = 73 cm	0.1966	15.844	6.6974	6.6974	0.6461	18.472	0.1688	0.9402	0.002	0.9552
PR ~ 1.3	0.192	15.825	6.3707	6.3707	0.6343	18.222	0.1688	0.9348	0.002	0.95
						18.404				0.9535
	0.1682	13.877	4.4478	4.4478	0.6089	15.249	0.1688	0.9335	0.002	0.9487
	0.1675	12.484	4.3354	4.3354	0.6785	13.926	0.1687	0.9309	0.002	0.9461
	0.1664	12.47	4.2281	4.2281	0.6673	13.846	0.1687	0.9322	0.002	0.9473
						14.34				0.9474
	0.1471	11.262	3.0999	3.0999	0.6548	12.104	0.1685	0.9322	0.002	0.9473
	0.1502	11.253	3.1707	3.1707	0.647	12.131	0.1684	0.9335	0.002	0.9486
	0.1493	11.261	3.1731	3.1731	0.6545	12.141	0.1684	0.9362	0.002	0.9512
						12.125				0.949
f ~ 1055	0.1968	15.827	6.6077	6.6077	0.6357	18.392	0.1684	0.824	0.002	0.841
L = 73 cm	0.192	15.84	6.4535	6.4535	0.6434	18.293	0.1686	0.8219	0.002	0.839
PR ~ 1.5	0.1898	15.845	6.3788	6.3788	0.6466	18.245	0.1685	0.8219	0.002	0.839
						18.31				0.8397
	0.1622	12.51	4.2419	4.2419	0.6989	13.893	0.1684	0.825	0.002	0.842
	0.1647	12.493	4.2698	4.2698	0.6859	13.894	0.1684	0.826	0.002	0.843
	0.1671	12.488	4.3368	4.3368	0.6815	13.93	0.1684	0.826	0.002	0.843
						13.906				0.8427
	0.1525	11.3	3.4275	3.4275	0.6881	12.316	0.1683	0.8229	0.002	0.84
	0.1491	11.292	3.2787	3.2787	0.6805	12.226	0.1683	0.8209	0.002	0.838
	0.1503	11.298	3.3415	3.3415	0.6855	12.266	0.1683	0.8219	0.002	0.839
						12.27				0.839
f ~ 1055	0.1858	14.072	6.1503	6.1503	0.7442	16.561	0.1683	0.7317	0.002	0.7508
L = 73 cm	0.1931	15.876	6.7109	6.7109	0.6656	18.51	0.1684	0.7309	0.002	0.75
PR ~ 1.7	0.1899	15.874	6.5465	6.5465	0.6644	18.39	0.1684	0.7309	0.002	0.75
						17.82				0.7503
	0.1687	12.527	4.5714	4.5714	0.7116	14.115	0.1683	0.7325	0.002	0.7516
	0.1656	12.549	4.5409	4.5409	0.7287	14.116	0.1682	0.7325	0.002	0.7516
	0.1624	12.535	4.353	4.353	0.718	13.984	0.1682	0.7325	0.002	0.7516
						14.072				0.7516
	0.146	10.395	3.1692	3.1692	0.7569	11.347	0.168	0.7333	0.002	0.7523
	0.1505	11.32	3.4335	3.4335	0.705	12.339	0.168	0.7309	0.002	0.75
	0.1481	11.32	3.3481	3.3481	0.7048	12.291	0.168	0.7317	0.002	0.7507
						11.992				0.751

Experiment Information	Ta (C)	Tto (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*λ	(2ΛΛ/π)	Gr β Rs*Rs	Rs Λ	PR %	SPL (dB)
f ~ 1055	24.3	32	31.5	7.16	0.07	7.61	1058	1	205	61.2	203	12	0.049	0.276	0.867	2697	1717	0.005	3.914	1.8866	156.6
L = 73 cm	24.3	32.3	31.7	7.45	0.07	7.73	1058	1	205	59.74	203	11.7	0.049	0.276	0.867	2697	1717	0.005	3.914	1.8866	156.6
PR ~ 1.9	24.4	32.6	32	7.63	0.07	7.95	1058	1.002	206	59.95	204	11.7	0.049	0.277	0.869	2697	1717	0.005	3.929	1.8904	156.6
										60.3	204	11.8	0.049	0.276	0.867	2697	1717	0.005	3.919		
	24.6	36.3	35.4	10.8	0.09	9.58	1058	0.999	205	65.52	203	12.8	0.049	0.276	0.866	2697	1717	0.007	3.904	1.8847	156.6
	24.8	35.5	34.8	9.95	0.08	9.14	1058	0.997	204	60.4	202	11.8	0.049	0.275	0.865	2697	1717	0.006	3.887	1.8809	156.6
	24.8	36.5	35.6	10.8	0.09	9.62	1058	0.996	204	65.81	201	12.9	0.049	0.275	0.864	2697	1717	0.007	3.88	1.879	156.6
										63.91	202	12.5	0.049	0.275	0.865	2697	1717	0.007	3.89		
	24.9	39.8	38.7	13.8	0.1	11.16	1059	0.996	204	66.68	202	13	0.049	0.275	0.863	2700	1719	0.009	3.884	1.879	156.6
	24.9	40.6	39.4	14.5	0.1	11.49	1059	0.998	205	65.03	203	12.7	0.049	0.275	0.865	2700	1719	0.009	3.9	1.8828	156.6
	25	40.5	39.4	14.4	0.1	11.24	1059	0.997	204	64.39	202	12.6	0.049	0.275	0.864	2700	1719	0.009	3.892	1.8809	156.6
										65.37	202	12.8	0.049	0.275	0.864	2700	1719	0.009	3.892		
f ~ 1055	22.1	29.8	29.1	7.03	0.08	8.21	1055	1.112	253	76.82	251	15	0.049	0.307	0.963	2690	1712	0.003	4.836	2.0979	157.5
L = 73 cm	22.2	30.5	29.8	7.61	0.08	8.47	1055	1.104	249	73.23	247	14.3	0.049	0.304	0.956	2690	1712	0.004	4.766	2.0828	157.5
PR ~ 2.1	22.3	30.3	29.6	7.32	0.08	8.29	1055	1.104	249	74.46	247	14.5	0.049	0.304	0.956	2690	1712	0.003	4.766	2.0828	157.5
										74.84	248	14.6	0.049	0.305	0.959	2690	1712	0.003	4.789		
	22.4	34.3	33.4	11	0.09	10.33	1055	1.102	248	69.8	246	13.6	0.049	0.304	0.955	2690	1712	0.005	4.748	2.079	157.4
	22.6	35.3	34.2	11.6	0.1	10.6	1055	1.101	248	75.02	246	14.7	0.049	0.304	0.954	2690	1712	0.005	4.738	2.0771	157.4
	22.8	35	33.9	11.1	0.1	10.39	1055	1.098	247	76.69	244	15	0.049	0.303	0.952	2690	1712	0.005	4.711	2.0715	157.4
										73.84	245	14.4	0.049	0.304	0.954	2690	1712	0.005	4.732		
	23	39.9	38.5	15.5	0.11	12.45	1056	1.102	249	72.64	246	14.2	0.049	0.304	0.955	2692	1714	0.007	4.75	2.079	157.4
	23.1	39.4	38	14.9	0.11	12.19	1056	1.103	249	73.84	247	14.4	0.049	0.304	0.956	2692	1714	0.007	4.758	2.0809	157.5
	23.1	39.7	38.3	15.2	0.11	12.39	1056	1.103	249	73.68	247	14.4	0.049	0.304	0.956	2692	1714	0.007	4.758	2.0809	157.5
										73.38	247	14.3	0.049	0.304	0.956	2692	1714	0.007	4.755		
f ~ 1055	23.1	31.1	30.4	7.32	0.08	8.35	1056	1.203	297	75.05	294	14.7	0.049	0.332	1.043	2692	1714	0.002	5.66	2.2696	158.2
L = 73 cm	23.1	31.3	30.6	7.5	0.08	8.54	1056	1.203	297	74.87	294	14.6	0.049	0.332	1.043	2692	1714	0.002	5.66	2.2696	158.2
PR ~ 2.3	23.1	31.5	30.8	7.69	0.08	8.76	1056	1.205	298	74.98	295	14.6	0.049	0.332	1.044	2692	1714	0.002	5.679	2.2733	158.2
										74.97	294	14.6	0.049	0.332	1.043	2692	1714	0.002	5.666		
	23.3	35.2	34.1	10.8	0.1	10.6	1056	1.202	296	80.56	293	15.7	0.049	0.332	1.042	2692	1714	0.003	5.649	2.2677	158.2
	23.4	35.6	34.5	11.1	0.1	10.8	1056	1.204	297	80.01	294	15.6	0.049	0.332	1.044	2692	1714	0.003	5.667	2.2714	158.2
	23.4	36	34.9	11.5	0.1	11.03	1056	1.2	295	79.04	292	15.4	0.049	0.331	1.041	2692	1714	0.004	5.629	2.2639	158.2
										79.87	293	15.6	0.049	0.332	1.042	2692	1714	0.004	5.648		
	23.6	40	38.4	14.8	0.12	12.77	1057	1.197	294	84.92	291	16.6	0.049	0.33	1.037	2695	1716	0.005	5.606	2.2582	158.2
	23.7	39.9	38.5	14.8	0.11	12.67	1057	1.199	295	77.54	292	15.2	0.049	0.331	1.039	2695	1716	0.005	5.624	2.262	158.2
	23.8	40.5	38.9	15.1	0.12	13	1057	1.2	295	84.9	292	16.6	0.049	0.331	1.04	2695	1716	0.005	5.633	2.2639	158.2
										82.46	292	16.1	0.049	0.331	1.039	2695	1716	0.005	5.621		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1055	0.1952	15.908	6.9862	6.9862	0.6848	18.74	0.1681	0.66	0.002	0.6811
L = 73 cm	0.1926	15.881	6.7128	6.7128	0.6683	18.515	0.1681	0.66	0.002	0.6811
PR ~ 1.9	0.1889	15.885	6.5507	6.5507	0.6708	18.402	0.168	0.6587	0.002	0.6798
						18.552				0.6806
	0.1669	12.554	4.6206	4.6206	0.733	14.173	0.1679	0.6607	0.002	0.6817
	0.1713	13.973	5.0228	5.0228	0.6758	15.691	0.1678	0.662	0.002	0.6829
	0.1665	12.558	4.6222	4.6222	0.7363	14.178	0.1678	0.6627	0.002	0.6836
						14.681				0.6827
	0.1511	11.368	3.6331	3.6331	0.746	12.498	0.1678	0.6627	0.002	0.6836
	0.1481	11.346	3.4415	3.4415	0.7276	12.369	0.1678	0.6613	0.002	0.6823
	0.1501	11.338	3.4833	3.4833	0.7204	12.384	0.1677	0.662	0.002	0.6829
						12.417				0.6829
f ~ 1055	0.1882	14.238	7.1119	7.1119	0.8595	17.454	0.1693	0.5935	0.002	0.6172
L = 73 cm	0.1833	14.18	6.5709	6.5709	0.8193	16.974	0.1693	0.5978	0.002	0.6213
PR ~ 2.1	0.1864	14.2	6.8269	6.8269	0.8331	17.192	0.1692	0.5978	0.002	0.6213
						17.207				0.62
	0.1595	12.616	4.5653	4.5653	0.781	14.194	0.1692	0.5989	0.002	0.6223
	0.1578	11.476	4.3031	4.3031	0.8393	13.018	0.1691	0.5995	0.002	0.6228
	0.1601	11.498	4.488	4.488	0.858	13.163	0.1689	0.6011	0.002	0.6244
						13.458				0.6232
	0.1421	10.455	3.225	3.225	0.8127	11.436	0.1688	0.5989	0.002	0.6223
	0.1441	10.469	3.3483	3.3483	0.8261	11.52	0.1688	0.5984	0.002	0.6217
	0.1426	10.467	3.2872	3.2872	0.8243	11.483	0.1688	0.5984	0.002	0.6217
						11.48				0.6219
f ~ 1055	0.1856	14.209	6.8315	6.8315	0.8397	17.204	0.1688	0.5486	0.002	0.574
L = 73 cm	0.1826	14.207	6.6635	6.6635	0.8377	17.069	0.1688	0.5486	0.002	0.574
PR ~ 2.3	0.1794	14.208	6.5057	6.5057	0.8389	16.949	0.1688	0.5477	0.002	0.5731
						17.074				0.5737
	0.1588	11.549	4.6213	4.6213	0.9013	13.301	0.1687	0.5491	0.002	0.5744
	0.1567	11.541	4.5049	4.5049	0.8952	13.214	0.1686	0.5482	0.002	0.5735
	0.1544	11.529	4.3571	4.3571	0.8843	13.103	0.1686	0.55	0.002	0.5753
						13.206				0.5744
	0.1418	9.7633	3.3697	3.3697	0.9501	10.907	0.1685	0.5514	0.002	0.5766
	0.1413	10.513	3.3831	3.3831	0.8676	11.584	0.1684	0.5505	0.002	0.5757
	0.1403	9.763	3.3091	3.3091	0.9498	10.869	0.1684	0.55	0.002	0.5752
						11.12				0.5758

Experiment Information	T a (C)	T to (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 1055	23.7	31.4	30.7	7	0.08	8.59	1057	1.301	347	80.73	344	15.8	0.049	0.359	1.128	2695	1716	0.002	6.622	2.4544	158.9
L = 73 cm	23.7	31.7	31	7.27	0.08	8.91	1057	1.302	348	80.59	344	15.7	0.049	0.359	1.128	2695	1716	0.002	6.632	2.4563	158.9
PR ~ 2.5	23.7	32.4	31.5	7.84	0.09	9.37	1057	1.302	348	88.45	344	17.3	0.049	0.359	1.128	2695	1716	0.002	6.632	2.4563	158.9
										83.25	344	16.3	0.049	0.359	1.128	2695	1716	0.002	6.629		
	23.9	35.8	34.7	10.8	0.1	10.96	1057	1.302	348	83.58	344	16.3	0.049	0.359	1.129	2695	1716	0.002	6.63	2.4563	158.9
	23.9	36.5	35.3	11.4	0.1	11.41	1057	1.302	348	82.04	344	16	0.049	0.359	1.129	2695	1716	0.003	6.63	2.4563	158.9
	23.9	36.2	35.1	11.2	0.1	11.18	1057	1.299	346	82.38	343	16.1	0.049	0.358	1.126	2695	1716	0.003	6.6	2.4507	158.9
										82.66	344	16.2	0.049	0.359	1.128	2695	1716	0.003	6.62		
	24	40.1	38.5	14.5	0.12	13.12	1057	1.296	345	89.32	341	17.5	0.049	0.358	1.124	2695	1716	0.003	6.568	2.445	158.9
	24	40.3	38.7	14.7	0.12	13.25	1057	1.296	345	89.07	341	17.4	0.049	0.358	1.124	2695	1716	0.003	6.568	2.445	158.9
	24.1	40.7	39.1	15	0.12	13.46	1057	1.293	343	88.82	339	17.4	0.049	0.357	1.121	2695	1716	0.003	6.537	2.4393	158.8
										89.07	340	17.4	0.049	0.357	1.123	2695	1716	0.003	6.558		
f ~ 585	23.4	31.3	30.4	6.97	0.09	10.09	587	1.102	448	107.1	447	20.9	0.027	0.547	1.719	1497	952.7	9E-04	11.55	2.079	157.4
L = 73 cm	23.6	32.3	31.2	7.62	0.1	10.64	587	1.101	448	114.9	446	22.4	0.027	0.547	1.718	1497	952.7	0.001	11.53	2.0771	157.4
PR ~ 2.1	23.7	32.9	31.8	8.1	0.1	10.81	587	1.099	446	109.8	445	21.4	0.027	0.546	1.715	1497	952.7	0.001	11.49	2.0733	157.4
										110.6	446	21.6	0.027	0.547	1.717	1497	952.7	0.001	11.52		
	23.8	36.3	34.9	11.1	0.11	12.56	587	1.099	446	102.4	445	20	0.027	0.546	1.715	1497	952.7	0.001	11.49	2.0733	157.4
	23.8	37.1	35.5	11.7	0.12	12.93	587	1.099	446	108.9	445	21.3	0.027	0.546	1.715	1497	952.7	0.002	11.49	2.0733	157.4
	24	36.1	34.7	10.7	0.11	12.15	588	1.099	446	102.4	445	20	0.027	0.545	1.713	1499	954.3	0.001	11.49	2.0733	157.4
										104.6	445	20.4	0.027	0.546	1.715	1497	953.3	0.002	11.49		
	24.2	39.5	37.8	13.6	0.12	13.89	588	1.097	444	100.8	443	19.7	0.027	0.545	1.711	1499	954.3	0.002	11.45	2.0696	157.4
	24.2	40.4	38.5	14.3	0.13	14.22	588	1.099	446	106.2	445	20.7	0.027	0.545	1.714	1499	954.3	0.002	11.49	2.0733	157.4
	24.3	40.3	38.4	14.1	0.13	14.22	588	1.099	446	107.7	445	21	0.027	0.546	1.714	1499	954.3	0.002	11.49	2.0733	157.4
										104.9	444	20.5	0.027	0.545	1.713	1499	954.3	0.002	11.48		
f ~ 585	24.3	32.8	31.7	7.41	0.1	10.66	588	1.2	532	118.2	531	23.1	0.027	0.596	1.872	1499	954.3	7E-04	13.7	2.2639	158.2
L = 73 cm	24.3	32.8	31.7	7.41	0.1	10.66	588	1.201	533	118.2	531	23.1	0.027	0.596	1.873	1499	954.3	7E-04	13.73	2.2658	158.2
PR ~ 2.3	24.3	33.2	32.1	7.79	0.1	10.89	588	1.202	534	115	532	22.5	0.027	0.597	1.875	1499	954.3	7E-04	13.75	2.2677	158.2
										117.1	531	22.9	0.027	0.596	1.873	1499	954.3	7E-04	13.73		
	24.4	36.4	35	10.6	0.11	12.85	588	1.2	532	110.1	531	21.5	0.027	0.596	1.872	1499	954.3	1E-03	13.71	2.2639	158.2
	24.4	36.7	35.1	10.7	0.12	13.01	588	1.202	534	119.9	532	23.4	0.027	0.597	1.875	1499	954.3	1E-03	13.75	2.2677	158.2
	24.5	37.3	35.7	11.2	0.12	13.35	588	1.201	533	118	532	23	0.027	0.596	1.874	1499	954.3	0.001	13.73	2.2658	158.2
										116	532	22.7	0.027	0.596	1.874	1499	954.3	1E-03	13.73		
	24.7	40.3	38.3	13.6	0.13	14.76	588	1.202	535	115.6	533	22.6	0.027	0.597	1.876	1499	954.3	0.001	13.76	2.2677	158.2
	24.7	40.7	38.7	14	0.13	14.94	588	1.2	533	113.9	531	22.3	0.027	0.596	1.873	1499	954.3	0.001	13.71	2.2639	158.2
	24.8	41.1	39.1	14.3	0.13	15.08	588	1.198	531	112.7	529	22	0.027	0.595	1.87	1499	954.3	0.001	13.67	2.2601	158.2
										114.1	531	22.3	0.027	0.596	1.873	1499	954.3	0.001	13.71		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1055	0.1831	14.301	7.1434	7.1434	0.9032	17.534	0.1684	0.5073	0.002	0.5345
L = 73 cm	0.1784	14.299	6.8744	6.8744	0.9016	17.315	0.1684	0.5069	0.002	0.5342
PR ~ 2.5	0.1739	12.884	6.3773	6.3773	0.9895	15.759	0.1684	0.5069	0.002	0.5342
						16.869				0.5343
	0.1559	11.588	4.637	4.637	0.9351	13.349	0.1683	0.5069	0.002	0.5341
	0.1516	11.568	4.3718	4.3718	0.9178	13.149	0.1683	0.5069	0.002	0.5341
	0.1537	11.572	4.4801	4.4801	0.9216	13.226	0.1683	0.5081	0.002	0.5352
						13.241				0.5345
	0.1402	9.8114	3.4494	3.4494	0.9993	11.004	0.1683	0.5093	0.002	0.5363
	0.1393	9.8087	3.4062	3.4062	0.9965	10.974	0.1683	0.5093	0.002	0.5363
	0.138	9.8059	3.3437	3.3437	0.9937	10.933	0.1682	0.5104	0.002	0.5374
						10.97				0.5367
f ~ 585	0.1689	13.152	7.1692	7.1692	1.1979	16.65	0.1686	0.5989	0.002	0.6222
L = 73 cm	0.1645	11.995	6.5656	6.5656	1.2854	15.225	0.1685	0.5995	0.002	0.6227
PR ~ 2.1	0.1619	11.929	6.1743	6.1743	1.2281	14.835	0.1684	0.6005	0.002	0.6237
						15.57				0.6229
	0.1461	10.809	4.5079	4.5079	1.146	12.602	0.1684	0.6005	0.002	0.6237
	0.1445	10.026	4.2668	4.2668	1.2182	11.766	0.1684	0.6005	0.002	0.6237
	0.1491	10.808	4.6565	4.6565	1.1451	12.709	0.1683	0.6005	0.002	0.6237
						12.359				0.6237
	0.1372	9.9368	3.6762	3.6762	1.1275	11.272	0.1682	0.6016	0.002	0.6247
	0.1362	9.2707	3.4927	3.4927	1.188	10.572	0.1682	0.6005	0.002	0.6236
	0.1364	9.286	3.5422	3.5422	1.2048	10.62	0.1681	0.6005	0.002	0.6236
						10.822				0.624
f ~ 585	0.1649	12.039	6.7446	6.7446	1.3229	15.417	0.1681	0.55	0.002	0.5751
L = 73 cm	0.1649	12.039	6.7446	6.7446	1.3229	15.417	0.1681	0.5495	0.002	0.5747
PR ~ 2.3	0.162	11.996	6.4186	6.4186	1.2861	15.099	0.1681	0.5491	0.002	0.5742
						15.311				0.5747
	0.1453	10.9	4.7352	4.7352	1.2316	12.852	0.168	0.55	0.002	0.5751
	0.1457	10.146	4.6692	4.6692	1.3413	12.181	0.168	0.5491	0.002	0.5742
	0.1432	10.125	4.4775	4.4775	1.3198	12.016	0.168	0.5495	0.002	0.5746
						12.35				0.5747
	0.1347	9.3658	3.6642	3.6642	1.2928	10.782	0.1679	0.5491	0.002	0.5742
	0.1334	9.3492	3.5663	3.5663	1.2745	10.7	0.1679	0.55	0.002	0.5751
	0.1326	9.337	3.4961	3.4961	1.2611	10.641	0.1678	0.5509	0.002	0.5759
						10.708				0.575

Experiment Information	Ta (C)	T lo (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 585	23	30.9	29.8	6.78	0.1	10.95	586	1.303	627	132.7	624	25.9	0.027	0.648	2.035	1494	951.1	5E-04	16.15	2.4582	158.9
L = 73 cm	22.9	31.2	30.1	7.16	0.1	11.22	587	1.303	625	128.9	624	25.2	0.027	0.646	2.031	1497	952.7	5E-04	16.13	2.4582	158.9
PR ~ 2.5	22.9	31.2	30.1	7.17	0.1	11.13	587	1.303	625	127.7	624	25	0.027	0.646	2.031	1497	952.7	5E-04	16.13	2.4582	158.9
										129.8	624	25.4	0.027	0.647	2.032	1496	952.2	5E-04	16.14		
	23.1	34.5	32.9	9.78	0.12	13.23	587	1.301	624	133.5	622	26.1	0.027	0.646	2.028	1497	952.7	7E-04	16.09	2.4544	158.9
	23.3	35.1	33.4	10.1	0.12	13.56	587	1.3	623	131.9	622	25.8	0.027	0.645	2.028	1497	952.7	7E-04	16.07	2.4526	158.9
	23.4	35.6	33.9	10.5	0.12	13.79	587	1.298	622	129.4	620	25.3	0.027	0.645	2.025	1497	952.7	7E-04	16.02	2.4488	158.9
										131.6	621	25.7	0.027	0.645	2.027	1497	952.7	7E-04	16.06		
	23.6	38.7	36.7	13.1	0.13	15.28	587	1.296	620	124.9	618	24.4	0.027	0.644	2.022	1497	952.7	9E-04	15.98	2.445	158.9
	23.7	39.3	37.1	13.4	0.14	15.6	587	1.297	621	134.3	619	26.2	0.027	0.644	2.024	1497	952.7	9E-04	16.01	2.4469	158.9
	23.8	40.1	37.8	14	0.14	15.9	587	1.296	621	130.5	618	25.5	0.027	0.644	2.023	1497	952.7	1E-03	15.98	2.445	158.9
										129.9	619	25.4	0.027	0.644	2.023	1497	952.7	9E-04	15.99		
f ~ 585	23.6	31.2	30	6.45	0.1	11.33	587	1.403	727	144.6	724	28.2	0.027	0.697	2.189	1497	952.7	3E-04	18.73	2.6469	159.5
L = 73 cm	23.7	32.3	30.9	7.25	0.11	12.05	587	1.402	726	150.4	724	29.4	0.027	0.696	2.188	1497	952.7	4E-04	18.7	2.645	159.5
PR ~ 2.6	23.7	32.6	31.2	7.51	0.11	12.38	587	1.403	727	149.1	725	29.1	0.027	0.697	2.19	1497	952.7	4E-04	18.73	2.6469	159.5
										148	724	28.9	0.027	0.697	2.189	1497	952.7	4E-04	18.72		
	23.9	35.4	33.5	9.63	0.13	14.1	587	1.4	724	156.5	722	30.6	0.027	0.696	2.186	1497	952.7	5E-04	18.66	2.6412	159.5
	24	36.2	34.3	10.3	0.13	14.52	588	1.405	729	151.1	727	29.5	0.027	0.697	2.19	1499	954.3	5E-04	18.77	2.6506	159.6
	24	36.6	34.7	10.7	0.13	14.63	588	1.406	730	146.7	728	28.7	0.027	0.698	2.192	1499	954.3	5E-04	18.8	2.6525	159.6
										151.4	725	29.6	0.027	0.697	2.189	1498	953.8	5E-04	18.74		
	24.3	39.7	37.4	13.1	0.14	16.21	588	1.402	726	142.6	724	27.9	0.027	0.696	2.187	1499	954.3	7E-04	18.7	2.645	159.5
	24.4	40.3	37.8	13.4	0.15	16.48	588	1.402	726	151.9	724	29.7	0.027	0.696	2.187	1499	954.3	7E-04	18.71	2.645	159.5
	24.4	40.3	37.8	13.4	0.15	16.5	588	1.405	730	152.1	727	29.7	0.027	0.698	2.192	1499	954.3	7E-04	18.79	2.6506	159.6
										148.9	725	29.1	0.027	0.697	2.188	1499	954.3	7E-04	18.73		
f ~ 585	24.3	32.9	31.5	7.2	0.11	12.5	588	1.501	832	157.1	830	30.7	0.027	0.745	2.341	1499	954.3	3E-04	21.44	2.8318	160.1
L = 73 cm	24.3	32.6	31.2	6.93	0.11	12.25	588	1.5	831	160	829	31.3	0.027	0.745	2.339	1499	954.3	3E-04	21.41	2.8299	160.1
PR ~ 2.8	22.8	31.1	29.7	6.92	0.11	12.34	587	1.504	833	161.4	831	31.5	0.027	0.746	2.344	1497	952.7	3E-04	21.48	2.8374	160.1
										159.5	830	31.2	0.027	0.745	2.341	1498	953.8	3E-04	21.44		
	23.1	35.3	33.3	10.2	0.13	15.09	587	1.501	830	158.1	828	30.9	0.027	0.745	2.34	1497	952.7	4E-04	21.41	2.8318	160.1
	23.2	35.3	33.3	10.1	0.13	14.92	587	1.5	830	157.6	827	30.8	0.027	0.745	2.339	1497	952.7	4E-04	21.39	2.8299	160.1
	23.3	35.7	33.7	10.4	0.13	15.1	587	1.499	829	155.2	826	30.3	0.027	0.744	2.338	1497	952.7	4E-04	21.36	2.828	160.1
										157	827	30.7	0.027	0.745	2.339	1497	952.7	4E-04	21.39		
	23.4	39	36.4	13	0.15	16.96	587	1.498	828	160.8	826	31.4	0.027	0.744	2.337	1497	952.7	5E-04	21.34	2.8261	160.1
	23.5	39.4	36.8	13.3	0.15	17.13	587	1.495	825	159.1	822	31.1	0.027	0.742	2.332	1497	952.7	5E-04	21.26	2.8204	160.1
	23.8	39.2	36.6	12.8	0.15	16.86	588	1.501	831	162.2	829	31.7	0.027	0.745	2.339	1499	954.3	5E-04	21.42	2.8318	160.1
										160.7	826	31.4	0.027	0.744	2.336	1497	953.3	5E-04	21.34		

Experiment Information	V uncert	I uncert	Ta uncert	To uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mid V uncert	f uncert	overall Rs uncert
f ~ 585	0.1646	12.228	7.3705	7.3705	1.485	16.137	0.1688	0.5065	0.002	0.5339
L = 73 cm	0.1614	12.178	6.9869	6.9869	1.4424	15.749	0.1689	0.5065	0.002	0.5339
PR ~ 2.5	0.162	12.163	6.9779	6.9779	1.429	15.728	0.1689	0.5065	0.002	0.5339
						15.872				0.5339
	0.1464	10.295	5.1116	5.1116	1.4932	12.668	0.1688	0.5073	0.002	0.5346
	0.144	10.278	4.9303	4.9303	1.4762	12.508	0.1687	0.5077	0.002	0.535
	0.1422	10.251	4.7559	4.7559	1.4481	12.346	0.1686	0.5085	0.002	0.5357
						12.508				0.5351
	0.1333	9.461	3.8241	3.8241	1.3977	10.988	0.1685	0.5093	0.002	0.5364
	0.1331	8.9152	3.7387	3.7387	1.5024	10.474	0.1684	0.5089	0.002	0.536
	0.1312	8.8789	3.5636	3.5636	1.4596	10.314	0.1684	0.5093	0.002	0.5364
						10.592				0.5363
f ~ 585	0.163	12.382	7.7579	7.7579	1.6173	16.623	0.1685	0.4704	0.002	0.4997
L = 73 cm	0.1578	11.379	6.8977	6.8977	1.6823	15.083	0.1684	0.4708	0.002	0.5
PR ~ 2.6	0.1549	11.363	6.6562	6.6562	1.6678	14.851	0.1684	0.4704	0.002	0.4997
						15.519				0.4998
	0.1444	9.7816	5.1913	5.1913	1.7509	12.356	0.1683	0.4714	0.002	0.5006
	0.1411	9.7263	4.8658	4.8658	1.69	12.034	0.1683	0.4698	0.002	0.499
	0.1399	9.6821	4.6899	4.6899	1.6412	11.851	0.1683	0.4694	0.002	0.4987
						12.08				0.4994
	0.1314	8.9939	3.8207	3.8207	1.5954	10.614	0.1681	0.4708	0.002	0.4999
	0.1315	8.5164	3.7369	3.7369	1.6997	10.167	0.168	0.4708	0.002	0.4999
	0.1315	8.5183	3.7377	3.7377	1.7022	10.169	0.168	0.4698	0.002	0.4989
						10.317				0.4995
f ~ 585	0.1553	11.458	6.946	6.946	1.7573	15.195	0.1681	0.4397	0.002	0.4707
L = 73 cm	0.1577	11.493	7.2188	7.2188	1.7898	15.477	0.1681	0.44	0.002	0.471
PR ~ 2.8	0.1573	11.51	7.2293	7.2293	1.8056	15.501	0.1689	0.4388	0.002	0.4702
						15.391				0.4707
	0.1391	9.7983	4.9018	4.9018	1.7693	12.133	0.1688	0.4397	0.002	0.471
	0.1399	9.7924	4.9393	4.9393	1.7628	12.158	0.1687	0.44	0.002	0.4712
	0.1386	9.7687	4.8082	4.8082	1.7367	12.029	0.1687	0.4403	0.002	0.4715
						12.107				0.4712
	0.1307	8.5956	3.8442	3.8442	1.7994	10.329	0.1686	0.4406	0.002	0.4718
	0.1298	8.5801	3.7649	3.7649	1.78	10.254	0.1685	0.4415	0.002	0.4726
	0.1313	8.6076	3.8995	3.8995	1.8146	10.383	0.1684	0.4397	0.002	0.4708
						10.322				0.4717

Experiment Information	Ta (C)	Tfc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 585	23.7	32.4	30.8	7.07	0.12	13.29	588	1.605	950	185.4	948	36.2	0.027	0.796	2.501	1499	954.3	2E-04	24.48	3.028	160.7
L = 73 cm	23.7	32.1	30.5	6.81	0.12	12.97	588	1.608	953	187.8	951	36.7	0.027	0.797	2.505	1499	954.3	2E-04	24.57	3.0336	160.7
PR ~ 3.0	23.7	32.2	30.6	6.9	0.12	13.05	588	1.608	953	186.5	951	36.4	0.027	0.797	2.505	1499	954.3	2E-04	24.57	3.0336	160.7
										186.6	950	36.5	0.027	0.797	2.504	1499	954.3	2E-04	24.54		
	23.9	35.8	33.6	9.72	0.14	15.28	588	1.606	952	181	949	35.4	0.027	0.797	2.503	1499	954.3	3E-04	24.52	3.0298	160.7
	24	36.1	33.9	9.91	0.14	15.35	588	1.604	950	178.3	947	34.8	0.027	0.796	2.5	1499	954.3	3E-04	24.47	3.0261	160.7
	24	36.3	34.1	10.1	0.14	15.46	588	1.603	948	176.3	946	34.5	0.027	0.795	2.499	1499	954.3	3E-04	24.44	3.0242	160.7
										178.5	948	34.9	0.027	0.796	2.501	1499	954.3	3E-04	24.48		
	24.1	39.2	36.6	12.5	0.15	17.2	588	1.603	949	170.1	946	33.2	0.027	0.796	2.499	1499	954.3	4E-04	24.44	3.0242	160.7
	24.2	39.6	36.9	12.7	0.15	17.49	588	1.6	945	169.5	943	33.1	0.027	0.794	2.495	1499	954.3	4E-04	24.36	3.0185	160.7
	24.2	39.8	37.1	12.9	0.15	17.6	588	1.601	947	168.2	944	32.9	0.027	0.795	2.497	1499	954.3	4E-04	24.39	3.0204	160.7
										169.3	945	33.1	0.027	0.795	2.497	1499	954.3	4E-04	24.39		
f ~ 585	21.9	31.1	29.4	7.5	0.12	13.91	586	1.701	1064	183	1062	35.8	0.027	0.844	2.651	1494	951.1	2E-04	27.46	3.2091	161.2
L = 73 cm	22.2	30.9	29.3	7.05	0.12	13.48	586	1.7	1064	188.6	1061	36.9	0.027	0.844	2.651	1494	951.1	2E-04	27.45	3.2072	161.2
PR ~ 3.2	22.2	30.7	29.1	6.88	0.12	13.21	586	1.699	1063	189.4	1060	37	0.027	0.843	2.649	1494	951.1	2E-04	27.42	3.2053	161.2
										187	1061	36.5	0.027	0.844	2.651	1494	951.1	2E-04	27.44		
	22.4	34.3	32.1	9.65	0.14	15.76	587	1.705	1069	188	1067	36.7	0.027	0.845	2.655	1497	952.7	2E-04	27.59	3.2166	161.2
	22.5	34.3	32	9.54	0.14	15.87	587	1.707	1072	191.6	1070	37.4	0.027	0.846	2.659	1497	952.7	2E-04	27.66	3.2204	161.2
	22.6	34.6	32.3	9.72	0.14	16.01	587	1.708	1073	189.7	1071	37.1	0.027	0.847	2.661	1497	952.7	2E-04	27.7	3.2223	161.2
										189.8	1070	37.1	0.027	0.846	2.658	1497	952.7	2E-04	27.65		
	22.9	37.7	34.8	11.9	0.16	17.67	587	1.706	1072	195.1	1070	38.1	0.027	0.846	2.659	1497	952.7	3E-04	27.65	3.2185	161.2
	23.1	39	36	12.9	0.16	18.39	587	1.705	1072	187.6	1069	36.6	0.027	0.846	2.658	1497	952.7	3E-04	27.63	3.2166	161.2
	23.2	39.1	36.1	12.9	0.16	18.39	587	1.704	1071	187.6	1068	36.6	0.027	0.846	2.657	1497	952.7	3E-04	27.6	3.2147	161.2
										190.1	1069	37.1	0.027	0.846	2.658	1497	952.7	3E-04	27.63		
f ~ 1055	23	31.5	30.8	7.83	0.08	8.23	1053	1.057	229	69.15	225	13.5	0.049	0.292	0.919	2685	1709	0.004	4.348	1.9941	157.1
L = 73 cm	23	31.6	30.8	7.83	0.08	8.23	1053	1.061	231	69.15	227	13.5	0.049	0.293	0.922	2685	1709	0.004	4.381	2.0017	157.1
PR ~ 2.0	23	31.6	30.9	7.92	0.08	8.29	1053	1.061	231	68.82	227	13.4	0.049	0.293	0.922	2685	1709	0.004	4.381	2.0017	157.1
										69.04	226	13.5	0.049	0.293	0.921	2685	1709	0.004	4.37		
	23	35.4	34.5	11.5	0.09	10.12	1053	1.054	228	65.29	224	12.8	0.049	0.292	0.916	2685	1709	0.006	4.323	1.9885	157.1
	23.1	35.6	34.7	11.6	0.09	10.24	1053	1.061	227	65.55	223	12.8	0.049	0.291	0.913	2685	1709	0.006	4.297	1.9828	157
	23.1	35.6	34.7	11.6	0.09	10.24	1053	1.051	227	65.55	223	12.8	0.049	0.291	0.913	2685	1709	0.006	4.297	1.9828	157
										65.46	223	12.8	0.049	0.291	0.914	2685	1709	0.006	4.306		
	23.2	40	38.6	15.4	0.11	12.26	1054	1.059	230	71.89	227	14	0.049	0.293	0.92	2687	1711	0.008	4.371	1.9979	157.1
	23.2	39.8	38.4	15.2	0.11	12.04	1054	1.059	230	71.41	227	14	0.049	0.293	0.92	2687	1711	0.008	4.371	1.9979	157.1
	23.2	40	38.6	15.4	0.11	12.18	1054	1.06	231	71.38	227	13.9	0.049	0.293	0.921	2687	1711	0.008	4.379	1.9998	157.1
										71.56	227	14	0.049	0.293	0.92	2687	1711	0.008	4.374		

Experiment Information	V uncert	f uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 585	0.154	10.863	7.0678	7.0678	2.074	14.908	0.1684	0.4112	0.002	0.4444
L = 73 cm	0.1567	10.89	7.3384	7.3384	2.1016	15.19	0.1684	0.4104	0.002	0.4437
PR ~ 3.0	0.1559	10.876	7.2425	7.2425	2.0869	15.085	0.1684	0.4104	0.002	0.4437
						15.061				0.4439
	0.1413	9.3576	5.1444	5.1444	2.0249	12.026	0.1683	0.411	0.002	0.4441
	0.1406	9.3324	5.0457	5.0457	1.9952	11.917	0.1683	0.4115	0.002	0.4446
	0.1398	9.3135	4.9536	4.9536	1.9728	11.821	0.1683	0.4117	0.002	0.4448
						11.921				0.4445
	0.1309	8.6781	4.0096	4.0096	1.9034	10.541	0.1682	0.4117	0.002	0.4448
	0.1297	8.6727	3.9291	3.9291	1.8967	10.474	0.1682	0.4125	0.002	0.4455
	0.1291	8.6607	3.8733	3.8733	1.8815	10.42	0.1682	0.4122	0.002	0.4452
						10.478				0.4452
f ~ 585	0.1495	10.838	6.668	6.668	2.048	14.512	0.1695	0.388	0.002	0.4234
L = 73 cm	0.1532	10.899	7.0911	7.0911	2.1106	14.961	0.1693	0.3882	0.002	0.4235
PR ~ 3.2	0.1552	10.907	7.2631	7.2631	2.1185	15.132	0.1693	0.3885	0.002	0.4238
						14.868				0.4236
	0.1399	9.424	5.1809	5.1809	2.1033	12.122	0.1692	0.3871	0.002	0.4225
	0.1399	9.4582	5.2437	5.2437	2.1437	12.209	0.1691	0.3866	0.002	0.422
	0.1389	9.4403	5.1466	5.1466	2.1225	12.109	0.1691	0.3864	0.002	0.4218
						12.147				0.4221
	0.1324	8.3822	4.1953	4.1953	2.1824	10.5	0.1689	0.3869	0.002	0.4221
	0.1286	8.3194	3.8758	3.8758	2.0984	10.182	0.1688	0.3871	0.002	0.4223
	0.1286	8.3194	3.8758	3.8758	2.0984	10.182	0.1687	0.3873	0.002	0.4225
						10.288				0.4223
f ~ 1055	0.1862	14.114	6.3866	6.3866	0.7737	16.776	0.1688	0.6244	0.002	0.6468
L = 73 cm	0.1862	14.114	6.3866	6.3866	0.7737	16.776	0.1688	0.6221	0.002	0.6446
PR ~ 2.0	0.1852	14.109	6.31	6.31	0.77	16.713	0.1688	0.6221	0.002	0.6446
						16.755				0.6453
	0.1609	12.551	4.3586	4.3586	0.7304	14.003	0.1688	0.6262	0.002	0.6486
	0.1597	12.555	4.3251	4.3251	0.7334	13.986	0.1688	0.628	0.002	0.6503
	0.1597	12.555	4.3251	4.3251	0.7334	13.986	0.1688	0.628	0.002	0.6503
						13.991				0.6497
	0.1433	10.446	3.2414	3.2414	0.8043	11.436	0.1687	0.6232	0.002	0.6457
	0.1448	10.44	3.2787	3.2787	0.799	11.452	0.1687	0.6232	0.002	0.6457
	0.1438	10.44	3.2395	3.2395	0.7986	11.429	0.1687	0.6226	0.002	0.6451
						11.439				0.6455

Experiment Information	Ta (C)	Tto (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 1055 Hz	23.2	31.7	31	7.81	0.08	8.52	1054	1.148	271	71.81	266	14	0.049	0.317	0.997	2687	1711	0.003	5.137	2.1658	157.8
L = 73 cm	23.2	31.9	31.2	7.99	0.08	8.66	1054	1.15	272	71.27	267	13.9	0.049	0.318	0.999	2687	1711	0.003	5.155	2.1696	157.8
PR ~ 2.2	23.2	31.9	31.2	7.99	0.08	8.66	1054	1.151	272	71.27	268	13.9	0.049	0.318	1	2687	1711	0.003	5.164	2.1715	157.8
										71.45	267	14	0.049	0.318	0.998	2687	1711	0.003	5.152		
	23.2	35.2	34.2	11	0.09	10.36	1054	1.154	273	69.39	269	13.6	0.049	0.319	1.002	2687	1711	0.004	5.19	2.1771	157.8
	23.3	35.2	34.3	11	0.09	10.27	1054	1.148	271	69.36	266	13.6	0.049	0.317	0.997	2687	1711	0.004	5.135	2.1658	157.8
	23.3	35.3	34.3	11	0.09	10.39	1054	1.15	272	69.61	267	13.6	0.049	0.318	0.999	2687	1711	0.004	5.153	2.1696	157.8
										69.45	267	13.6	0.049	0.318	0.999	2687	1711	0.004	5.16		
	23.3	39.3	37.9	14.6	0.11	12.24	1054	1.149	271	75.69	267	14.8	0.049	0.318	0.998	2687	1711	0.006	5.144	2.1677	157.8
	23.5	39.6	38.2	14.7	0.11	12.38	1054	1.148	271	76.12	266	14.9	0.049	0.318	0.997	2687	1711	0.006	5.132	2.1658	157.8
	23.5	39.7	38.3	14.8	0.11	12.38	1054	1.148	271	75.6	266	14.8	0.049	0.318	0.997	2687	1711	0.006	5.132	2.1658	157.8
										75.8	266	14.8	0.049	0.318	0.998	2687	1711	0.006	5.136		
f ~ 1055 Hz	22.8	31.1	30.4	7.57	0.08	8.91	1054	1.249	320	77.39	315	15.1	0.049	0.345	1.084	2687	1711	0.002	6.086	2.3563	158.5
L = 73 cm	22.9	31.2	30.5	7.57	0.08	9	1054	1.254	323	78.25	318	15.3	0.049	0.346	1.088	2687	1711	0.002	6.134	2.3658	158.6
PR ~ 2.4	22.9	31.3	30.6	7.66	0.08	9.07	1054	1.252	322	77.89	317	15.2	0.049	0.346	1.087	2687	1711	0.002	6.114	2.362	158.6
										77.85	317	15.2	0.049	0.346	1.086	2687	1711	0.002	6.111		
	23.2	34.6	33.5	10.3	0.1	10.51	1054	1.243	317	83.67	312	16.3	0.049	0.344	1.079	2687	1711	0.003	6.022	2.345	158.5
	23.2	35	33.9	10.7	0.1	10.9	1055	1.245	318	83.85	314	16.4	0.049	0.344	1.08	2690	1712	0.003	6.052	2.3488	158.5
	23.2	35.4	34.3	11.1	0.1	11.08	1055	1.249	320	82.3	316	16.1	0.049	0.345	1.084	2690	1712	0.003	6.091	2.3563	158.5
										83.28	314	16.3	0.049	0.344	1.081	2689	1712	0.003	6.055		
	23.4	39.7	38.1	14.7	0.12	12.96	1055	1.254	323	86.91	318	17	0.049	0.346	1.088	2690	1712	0.004	6.137	2.3658	158.6
	23.4	39.8	38.2	14.8	0.12	13.03	1055	1.254	323	86.84	318	17	0.049	0.346	1.088	2690	1712	0.004	6.137	2.3658	158.6
	23.5	40.1	38.5	15	0.12	13.1	1055	1.255	323	86.19	319	16.8	0.049	0.347	1.089	2690	1712	0.004	6.146	2.3677	158.6
										86.65	318	16.9	0.049	0.347	1.089	2690	1712	0.004	6.14		
f ~ 1055 Hz	23.4	31.4	30.7	7.26	0.08	9.08	1055	1.363	381	82.28	376	16.1	0.049	0.377	1.183	2690	1712	0.001	7.251	2.5714	159.3
L = 73 cm	23.4	31.5	30.8	7.35	0.08	9.19	1055	1.362	381	82.25	375	16.1	0.049	0.376	1.182	2690	1712	0.001	7.24	2.5695	159.3
PR ~ 2.6	23.4	31.7	31	7.55	0.08	9.19	1055	1.361	380	80.07	375	15.6	0.049	0.376	1.181	2690	1712	0.001	7.229	2.5676	159.3
										81.53	375	15.9	0.049	0.376	1.182	2690	1712	0.001	7.24		
	23.5	35.4	34.3	10.8	0.1	11.28	1055	1.36	380	86.28	374	16.9	0.049	0.376	1.181	2690	1712	0.002	7.217	2.5657	159.3
	23.6	36	34.8	11.2	0.1	11.44	1055	1.36	380	83.74	374	16.4	0.049	0.376	1.181	2690	1712	0.002	7.215	2.5657	159.3
	23.6	36	34.8	11.2	0.1	11.44	1055	1.359	379	83.74	374	16.4	0.049	0.376	1.18	2690	1712	0.002	7.205	2.5639	159.3
										84.59	374	16.5	0.049	0.376	1.18	2690	1712	0.002	7.212		
	23.7	40	38.4	14.7	0.12	13.45	1055	1.356	378	90.56	372	17.7	0.049	0.375	1.178	2690	1712	0.003	7.171	2.5582	159.2
	23.7	40	38.4	14.7	0.12	13.32	1055	1.355	377	89.59	371	17.5	0.049	0.375	1.177	2690	1712	0.003	7.161	2.5563	159.2
	23.8	40.1	38.5	14.7	0.12	13.32	1055	1.353	376	89.59	370	17.5	0.049	0.374	1.175	2690	1712	0.003	7.138	2.5525	159.2
										89.92	371	17.6	0.049	0.374	1.176	2690	1712	0.003	7.156		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1055 Hz	0.1823	14.157	6.406	6.406	0.8034	16.828	0.1687	0.5749	0.002	0.5992
L = 73 cm	0.1801	14.148	6.2549	6.2549	0.7973	16.706	0.1687	0.5739	0.002	0.5982
PR ~ 2.2	0.1801	14.148	6.2549	6.2549	0.7973	16.706	0.1687	0.5734	0.002	0.5977
						16.747				0.5984
	0.1591	12.61	4.5251	4.5251	0.7763	14.163	0.1687	0.5719	0.002	0.5963
	0.16	12.609	4.563	4.563	0.776	14.187	0.1687	0.5749	0.002	0.5991
	0.1589	12.613	4.5262	4.5262	0.7788	14.167	0.1687	0.5739	0.002	0.5982
						14.172				0.5979
	0.1441	10.491	3.4182	3.4182	0.8468	11.583	0.1687	0.5744	0.002	0.5987
	0.1431	10.496	3.3986	3.3986	0.8516	11.576	0.1685	0.5749	0.002	0.5991
	0.143	10.49	3.3757	3.3757	0.8458	11.557	0.1685	0.5749	0.002	0.5991
						11.572				0.599
f ~ 1055 Hz	0.1778	14.247	6.6021	6.6021	0.8659	17.057	0.1689	0.5284	0.002	0.5548
L = 73 cm	0.1767	14.261	6.6085	6.6085	0.8755	17.074	0.1689	0.5263	0.002	0.5528
PR ~ 2.4	0.1757	14.255	6.5271	6.5271	0.8714	17.006	0.1689	0.5272	0.002	0.5536
						17.046				0.5537
	0.1602	11.589	4.8409	4.8409	0.9362	13.494	0.1687	0.531	0.002	0.5571
	0.1565	11.591	4.6778	4.6778	0.9382	13.38	0.1687	0.5301	0.002	0.5563
	0.1546	11.571	4.5165	4.5165	0.9208	13.25	0.1687	0.5284	0.002	0.5547
						13.375				0.5561
	0.1409	9.785	3.398	3.398	0.9724	10.946	0.1686	0.5263	0.002	0.5527
	0.1404	9.7842	3.377	3.377	0.9716	10.932	0.1686	0.5263	0.002	0.5527
	0.1398	9.7772	3.3339	3.3339	0.9643	10.898	0.1685	0.5259	0.002	0.5522
						10.925				0.5525
f ~ 1055 Hz	0.1765	14.326	6.8875	6.8875	0.9206	17.349	0.1686	0.4842	0.002	0.5127
L = 73 cm	0.175	14.325	6.8022	6.8022	0.9202	17.281	0.1686	0.4846	0.002	0.5131
PR ~ 2.6	0.1746	14.29	6.622	6.622	0.8958	17.11	0.1686	0.4849	0.002	0.5134
						17.247				0.5131
	0.1535	11.623	4.6511	4.6511	0.9653	13.391	0.1685	0.4853	0.002	0.5137
	0.1517	11.59	4.4508	4.4508	0.9369	13.223	0.1685	0.4853	0.002	0.5137
	0.1517	11.59	4.4508	4.4508	0.9369	13.223	0.1685	0.4857	0.002	0.5141
						13.279				0.5138
	0.1383	9.825	3.4119	3.4119	1.0132	10.994	0.1684	0.4867	0.002	0.515
	0.139	9.8144	3.4082	3.4082	1.0024	10.981	0.1684	0.4871	0.002	0.5154
	0.139	9.8144	3.4082	3.4082	1.0024	10.981	0.1684	0.4878	0.002	0.5161
						10.985				0.5155

Experiment Information	Ta (C)	Tto (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mid V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs Λ	PR %	SPL (dB)
f ~ 900 Hz	23	30.7	30.2	7.2	0.07	7.07	897	0.502	60.8	56.56	60.6	11.1	0.041	0.163	0.512	2287	1456	0.054	1.268	0.9471	150.6
L = 67 cm	23.1	31	30.5	7.39	0.07	7.15	897	0.502	60.8	55.69	60.6	10.9	0.041	0.163	0.512	2287	1456	0.055	1.268	0.9471	150.6
PR ~ 0.9	23.1	31	30.5	7.39	0.07	7.21	897	0.502	60.8	56.19	60.6	11	0.041	0.163	0.512	2287	1456	0.055	1.268	0.9471	150.6
										56.15	60.6	11	0.041	0.163	0.512	2287	1456	0.055	1.268		
	23.2	35.3	34.6	11.4	0.08	9.04	897	0.503	61	52.34	60.9	10.2	0.041	0.163	0.513	2287	1456	0.084	1.273	0.9489	150.6
	23.2	35.6	34.9	11.7	0.08	9.16	897	0.502	60.8	51.71	60.6	10.1	0.041	0.163	0.512	2287	1456	0.087	1.268	0.9471	150.6
	23.2	35.6	34.8	11.6	0.08	9.24	897	0.502	60.8	52.19	60.6	10.2	0.041	0.163	0.512	2287	1456	0.087	1.268	0.9471	150.6
										52.08	60.7	10.2	0.041	0.163	0.513	2287	1456	0.086	1.27		
	23.3	39	38.1	14.8	0.09	10.28	897	0.502	60.8	51.56	60.6	10.1	0.041	0.163	0.512	2287	1456	0.109	1.268	0.9471	150.6
	23.4	38.9	38	14.6	0.09	10.08	897	0.503	61.1	51.18	60.9	10	0.041	0.163	0.513	2287	1456	0.107	1.273	0.9489	150.6
	23.4	38.9	38	14.6	0.09	10.12	897	0.503	61.1	51.4	60.9	10	0.041	0.163	0.513	2287	1456	0.107	1.273	0.9489	150.6
										51.38	60.8	10	0.041	0.163	0.513	2287	1456	0.108	1.272		
f ~ 900 Hz	23.4	31.3	30.8	7.39	0.07	7.14	897	0.601	87.2	55.61	86.9	10.9	0.041	0.195	0.614	2287	1456	0.027	1.818	1.1338	152.2
L = 67 cm	23.4	31.5	31	7.58	0.07	7.23	897	0.601	87.2	54.87	86.9	10.7	0.041	0.195	0.614	2287	1456	0.027	1.818	1.1338	152.2
PR ~ 1.1	23.4	31.6	31.1	7.68	0.07	7.26	897	0.601	87.2	54.4	86.9	10.6	0.041	0.195	0.614	2287	1456	0.028	1.818	1.1338	152.2
										54.96	86.9	10.7	0.041	0.195	0.614	2287	1456	0.027	1.818		
	23.4	35.6	34.9	11.5	0.08	9.08	897	0.601	87.2	52.12	86.9	10.2	0.041	0.195	0.614	2287	1456	0.041	1.818	1.1338	152.2
	23.5	35.7	35	11.5	0.08	9.08	897	0.601	87.2	52.12	86.9	10.2	0.041	0.195	0.614	2287	1456	0.041	1.818	1.1338	152.2
	23.5	35.7	35	11.5	0.08	9.14	897	0.602	87.5	52.49	87.2	10.3	0.041	0.196	0.615	2287	1456	0.041	1.824	1.1357	152.2
										52.25	87	10.2	0.041	0.195	0.614	2287	1456	0.041	1.82		
	23.5	38.8	37.9	14.4	0.09	10.21	897	0.602	87.5	52.61	87.2	10.3	0.041	0.196	0.615	2287	1456	0.051	1.824	1.1357	152.2
	23.5	38.7	37.8	14.3	0.09	10.21	897	0.602	87.5	52.98	87.2	10.4	0.041	0.196	0.615	2287	1456	0.051	1.824	1.1357	152.2
	23.5	38.9	38	14.5	0.09	10.32	897	0.602	87.5	52.84	87.2	10.3	0.041	0.196	0.615	2287	1456	0.051	1.824	1.1357	152.2
										52.81	87.2	10.3	0.041	0.196	0.615	2287	1456	0.051	1.824		
f ~ 900 Hz	23.3	31.7	31.1	7.84	0.07	7.82	897	0.704	120	57.4	119	11.2	0.041	0.229	0.719	2287	1456	0.015	2.494	1.3282	153.6
L = 67 cm	23.3	31.9	31.3	8.04	0.07	7.82	897	0.705	120	55.97	120	10.9	0.041	0.229	0.72	2287	1456	0.015	2.501	1.33	153.6
PR ~ 1.3	23.3	32	31.4	8.14	0.07	7.9	897	0.704	120	55.89	119	10.9	0.041	0.229	0.719	2287	1456	0.016	2.494	1.3282	153.6
										56.42	119	11	0.041	0.229	0.719	2287	1456	0.015	2.497		
	23.4	35.9	35	11.6	0.09	9.51	897	0.704	120	60.53	119	11.8	0.041	0.229	0.719	2287	1456	0.022	2.495	1.3282	153.6
	23.4	36	35.1	11.7	0.09	9.51	897	0.704	120	60.01	119	11.7	0.041	0.229	0.719	2287	1456	0.022	2.495	1.3282	153.6
	23.5	36.1	35.2	11.7	0.09	9.61	897	0.704	120	60.69	119	11.9	0.041	0.229	0.719	2287	1456	0.022	2.495	1.3282	153.6
										60.41	119	11.8	0.041	0.229	0.719	2287	1456	0.022	2.495		
	23.7	39.9	38.8	15.1	0.1	10.91	897	0.704	120	59.46	119	11.6	0.041	0.229	0.719	2287	1456	0.028	2.495	1.3282	153.6
	23.7	40	38.9	15.2	0.1	10.91	897	0.704	120	59.07	119	11.5	0.041	0.229	0.719	2287	1456	0.029	2.495	1.3282	153.6
	23.7	40.1	39	15.3	0.1	10.98	897	0.704	120	59.09	119	11.5	0.041	0.229	0.719	2287	1456	0.029	2.495	1.3282	153.6
										59.21	119	11.6	0.041	0.229	0.719	2287	1456	0.029	2.495		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 900 Hz	0.2049	15.822	6.9488	6.9488	0.6328	18.638	0.1688	1.3147	0.002	1.3255
L = 67 cm	0.203	15.807	6.7661	6.7661	0.6231	18.489	0.1688	1.3147	0.002	1.3255
PR ~ 0.9	0.2018	15.816	6.77	6.77	0.6287	18.5	0.1688	1.3147	0.002	1.3255
						18.542				1.3255
	0.171	13.843	4.4003	4.4003	0.5855	15.19	0.1687	1.3121	0.002	1.3229
	0.1694	13.833	4.2907	4.2907	0.5785	15.118	0.1687	1.3147	0.002	1.3255
	0.1685	13.841	4.2931	4.2931	0.5839	15.126	0.1687	1.3147	0.002	1.3255
						15.145				1.3247
	0.1567	12.353	3.3882	3.3882	0.5768	13.263	0.1687	1.3147	0.002	1.3255
	0.1587	12.348	3.4305	3.4305	0.5726	13.28	0.1686	1.3121	0.002	1.3229
	0.1583	12.351	3.4313	3.4313	0.575	13.283	0.1686	1.3121	0.002	1.3229
						13.276				1.3238
f ~ 900 Hz	0.2032	15.805	6.7654	6.7654	0.6222	18.487	0.1686	1.0982	0.002	1.111
L = 67 cm	0.2011	15.792	6.5927	6.5927	0.6139	18.35	0.1686	1.0982	0.002	1.111
PR ~ 1.1	0.2004	15.783	6.5088	6.5088	0.6086	18.282	0.1686	1.0982	0.002	1.111
						18.373				1.111
	0.1705	13.84	4.3632	4.3632	0.5832	15.165	0.1686	1.0982	0.002	1.111
	0.1705	13.84	4.3632	4.3632	0.5832	15.165	0.1685	1.0982	0.002	1.111
	0.1698	13.846	4.365	4.365	0.5873	15.172	0.1685	1.0963	0.002	1.1092
						15.168				1.1104
	0.1576	12.368	3.4811	3.4811	0.5886	13.326	0.1685	1.0963	0.002	1.1092
	0.1577	12.374	3.5055	3.5055	0.5927	13.344	0.1685	1.0963	0.002	1.1092
	0.1565	12.372	3.4594	3.4594	0.5912	13.318	0.1685	1.0963	0.002	1.1092
						13.329				1.1092
f ~ 900 Hz	0.1905	15.838	6.3759	6.3759	0.6422	18.237	0.1687	0.9375	0.002	0.9526
L = 67 cm	0.1902	15.812	6.2174	6.2174	0.6262	18.104	0.1687	0.9362	0.002	0.9512
PR ~ 1.3	0.1888	15.81	6.1453	6.1453	0.6253	18.053	0.1687	0.9375	0.002	0.9526
						18.131				0.9521
	0.1668	12.482	4.3001	4.3001	0.6772	13.902	0.1686	0.9375	0.002	0.9525
	0.1667	12.475	4.2635	4.2635	0.6714	13.873	0.1686	0.9375	0.002	0.9525
	0.1656	12.485	4.2668	4.2668	0.679	13.884	0.1685	0.9375	0.002	0.9525
						13.886				0.9525
	0.1521	11.274	3.3139	3.3139	0.6652	12.228	0.1684	0.9375	0.002	0.9525
	0.152	11.269	3.2921	3.2921	0.6609	12.212	0.1684	0.9375	0.002	0.9525
	0.1514	11.269	3.2721	3.2721	0.6611	12.201	0.1684	0.9375	0.002	0.9525
						12.214				0.9525

Experiment Information	Ta (C)	Tto (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs Λ	PR %	SPL (dB)
f ~ 900 Hz	23.5	32.5	31.9	8.43	0.07	8	897	0.801	155	54.63	154	10.7	0.041	0.26	0.818	2287	1456	0.01	3.23	1.5111	154.7
L = 67 cm	23.5	32.6	32	8.53	0.07	8	897	0.801	155	53.99	154	10.5	0.041	0.26	0.818	2287	1456	0.01	3.23	1.5111	154.7
PR ~ 1.5	23.5	32.7	32.1	8.62	0.07	8.12	897	0.801	155	54.22	154	10.6	0.041	0.26	0.818	2287	1456	0.01	3.23	1.5111	154.7
										54.28	154	10.6	0.041	0.26	0.818	2287	1456	0.01	3.23		
	23.5	36	35.1	11.6	0.09	9.79	897	0.801	155	62.45	154	12.2	0.041	0.26	0.818	2287	1456	0.013	3.23	1.5111	154.7
	23.6	36.1	35.2	11.6	0.09	9.79	897	0.801	155	62.45	154	12.2	0.041	0.26	0.818	2287	1456	0.013	3.23	1.5111	154.7
	23.6	36	35.1	11.5	0.09	9.85	897	0.801	155	63.41	154	12.4	0.041	0.26	0.818	2287	1456	0.013	3.23	1.5111	154.7
										62.77	154	12.3	0.041	0.26	0.818	2287	1456	0.013	3.23		
	23.6	39.5	38.4	14.8	0.1	11.03	897	0.8	155	61.38	154	12	0.041	0.26	0.817	2287	1456	0.017	3.222	1.5093	154.7
	23.7	39.4	38.3	14.6	0.1	11.03	897	0.8	155	62.23	154	12.2	0.041	0.26	0.817	2287	1456	0.016	3.222	1.5093	154.7
	23.7	39.5	38.4	14.7	0.1	11.14	897	0.8	155	62.47	154	12.2	0.041	0.26	0.817	2287	1456	0.017	3.222	1.5093	154.7
										62.03	154	12.1	0.041	0.26	0.817	2287	1456	0.017	3.222		
f ~ 585 Hz	22.2	29.8	28.7	6.53	0.1	10.51	585	1.252	578	132.4	576	25.9	0.027	0.623	1.956	1491	949.5	6E-04	14.9	2.362	158.6
L = 73 cm	22.3	30.4	29.3	7.01	0.1	10.71	586	1.253	578	125.7	576	24.6	0.027	0.622	1.954	1494	951.1	6E-04	14.92	2.3639	158.6
PR ~ 2.3	22.3	30.5	29.4	7.11	0.1	10.74	586	1.254	579	124.3	577	24.3	0.027	0.623	1.956	1494	951.1	6E-04	14.94	2.3658	158.6
										127.4	576	24.9	0.027	0.622	1.955	1493	950.6	6E-04	14.92		
	22.5	34.4	32.8	10.3	0.12	12.87	586	1.255	580	123	579	24	0.027	0.623	1.958	1494	951.1	9E-04	14.97	2.3677	158.6
	22.5	34.4	32.8	10.3	0.12	12.95	586	1.256	581	123.9	579	24.2	0.027	0.624	1.96	1494	951.1	9E-04	14.99	2.3695	158.6
	22.6	34.4	32.8	10.2	0.12	12.91	586	1.255	581	124.6	579	24.4	0.027	0.623	1.958	1494	951.1	9E-04	14.97	2.3677	158.6
										123.8	579	24.2	0.027	0.623	1.959	1494	951.1	9E-04	14.98		
	22.7	37.9	35.9	13.2	0.13	14.75	586	1.255	581	119	579	23.3	0.027	0.623	1.959	1494	951.1	0.001	14.97	2.3677	158.6
	22.9	38.8	36.8	13.9	0.13	15.04	586	1.252	578	115.6	576	22.6	0.027	0.622	1.955	1494	951.1	0.001	14.91	2.362	158.6
	22.9	38.7	36.7	13.8	0.13	14.96	586	1.251	577	115.7	575	22.6	0.027	0.622	1.953	1494	951.1	0.001	14.88	2.3601	158.5
										116.8	577	22.8	0.027	0.622	1.956	1494	951.1	0.001	14.92		
f ~ 585 Hz	22.9	30.8	29.7	6.77	0.1	11.08	586	1.359	681	134.6	679	26.3	0.027	0.675	2.122	1494	951.1	4E-04	17.57	2.5639	159.3
L = 73 cm	23	30.9	29.8	6.76	0.1	11.2	586	1.359	682	136.3	679	26.6	0.027	0.675	2.122	1494	951.1	4E-04	17.57	2.5639	159.3
PR ~ 2.6	23	31	29.8	6.85	0.1	11.29	586	1.358	681	135.5	678	26.5	0.027	0.675	2.121	1494	951.1	4E-04	17.54	2.562	159.3
										135.5	679	26.5	0.027	0.675	2.121	1494	951.1	4E-04	17.56		
	23.1	34.2	32.6	9.47	0.12	13.35	586	1.359	682	139.1	679	27.2	0.027	0.676	2.122	1494	951.1	6E-04	17.57	2.5639	159.3
	23.2	34.8	33.1	9.94	0.12	13.59	586	1.358	681	134.9	678	26.4	0.027	0.675	2.121	1494	951.1	6E-04	17.55	2.562	159.3
	23.3	35.2	33.5	10.2	0.12	13.89	587	1.354	676	134.4	674	26.3	0.027	0.672	2.112	1497	952.7	6E-04	17.43	2.5544	159.2
										136.2	677	26.6	0.027	0.674	2.118	1495	951.6	6E-04	17.52		
	23.3	39	36.7	13.4	0.14	16.16	587	1.356	678	138.9	676	27.1	0.027	0.673	2.115	1497	952.7	8E-04	17.48	2.5582	159.2
	23.4	40.5	38	14.6	0.15	16.65	587	1.368	680	141.1	678	27.6	0.027	0.674	2.118	1497	952.7	9E-04	17.54	2.562	159.3
	23.5	39.6	37.3	13.8	0.14	16.21	587	1.358	681	135.4	679	26.4	0.027	0.675	2.12	1496	952.3	8E-04	17.55	2.562	159.3
										138.5	678	27.1	0.027	0.674	2.118	1496	952.6	8E-04	17.52		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 900 Hz	0.1869	15.787	5.9318	5.9318	0.6112	17.889	0.1685	0.824	0.002	0.841
L = 67 cm	0.1867	15.775	5.8622	5.8622	0.604	17.832	0.1685	0.824	0.002	0.841
PR ~ 1.5	0.1848	15.779	5.8001	5.8001	0.6066	17.795	0.1685	0.824	0.002	0.841
						17.839				0.841
	0.1639	12.51	4.3097	4.3097	0.6987	13.934	0.1685	0.824	0.002	0.841
	0.1639	12.51	4.3097	4.3097	0.6987	13.934	0.1685	0.824	0.002	0.841
	0.1634	12.524	4.3492	4.3492	0.7094	13.972	0.1685	0.824	0.002	0.841
						13.947				0.841
	0.1514	11.299	3.3839	3.3839	0.6868	12.291	0.1685	0.825	0.002	0.842
	0.1515	11.31	3.4304	3.4304	0.6962	12.327	0.1684	0.825	0.002	0.842
	0.1506	11.313	3.4096	3.4096	0.6989	12.319	0.1684	0.825	0.002	0.842
						12.312				0.842
f ~ 585 Hz	0.169	12.223	7.6586	7.6586	1.481	16.399	0.1693	0.5272	0.002	0.5537
L = 73 cm	0.1657	12.136	7.1344	7.1344	1.4059	15.845	0.1692	0.5267	0.002	0.5533
PR ~ 2.3	0.1652	12.118	7.0371	7.0371	1.3906	15.743	0.1692	0.5263	0.002	0.5529
						15.996				0.5533
	0.1472	10.18	4.8423	4.8423	1.376	12.347	0.1691	0.5259	0.002	0.5524
	0.1468	10.19	4.8469	4.8469	1.3859	12.36	0.1691	0.5255	0.002	0.552
	0.1472	10.198	4.892	4.892	1.3945	12.403	0.1691	0.5259	0.002	0.5524
						12.37				0.5523
	0.1352	9.4013	3.7749	3.7749	1.3319	10.894	0.169	0.5259	0.002	0.5524
	0.1332	9.3664	3.5953	3.5953	1.2934	10.737	0.1689	0.5272	0.002	0.5536
	0.1336	9.3677	3.6186	3.6186	1.2949	10.753	0.1689	0.5276	0.002	0.554
						10.795				0.5533
f ~ 585 Hz	0.1636	12.252	7.3849	7.3849	1.5056	16.17	0.1689	0.4857	0.002	0.5142
L = 73 cm	0.1628	12.274	7.3983	7.3983	1.5246	16.201	0.1688	0.4857	0.002	0.5142
PR ~ 2.6	0.1619	12.264	7.3002	7.3002	1.5165	16.104	0.1688	0.486	0.002	0.5145
						16.158				0.5143
	0.1465	10.357	5.2815	5.2815	1.5568	12.865	0.1688	0.4857	0.002	0.5141
	0.1443	10.311	5.0314	5.0314	1.5098	12.619	0.1687	0.486	0.002	0.5145
	0.1423	10.305	4.9015	4.9015	1.5033	12.511	0.1687	0.4874	0.002	0.5158
						12.665				0.5148
	0.1311	8.9588	3.7331	3.7331	1.554	10.515	0.1687	0.4867	0.002	0.5151
	0.1293	8.4203	3.4355	3.4355	1.5787	9.8496	0.1686	0.486	0.002	0.5144
	0.1304	8.9253	3.6267	3.6267	1.5144	10.406	0.1685	0.486	0.002	0.5144
						10.257				0.5147

Experiment Information	Ta (C)	Tb (C)	Ts (C)	Ts-Ta (C)	Curr (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs Λ	PR %	SPL (dB)
f ~ 585 Hz	23.4	31.6	30.3	6.88	0.11	11.8	587	1.452	778	155.2	776	30.3	0.027	0.721	2.265	1497	952.7	3E-04	20.05	2.7393	159.8
L = 73 cm	23.3	31.7	30.4	7.06	0.11	11.92	587	1.453	779	152.6	777	29.8	0.027	0.721	2.266	1497	952.7	3E-04	20.07	2.7412	159.8
PR ~ 2.7	23.4	31.6	30.3	6.87	0.11	11.86	587	1.45	776	156.2	773	30.5	0.027	0.72	2.262	1497	952.7	3E-04	19.99	2.7355	159.8
										154.7	775	30.2	0.027	0.721	2.264	1497	952.7	3E-04	20.04		
	23.3	35.3	33.4	10.1	0.13	14.44	587	1.454	780	153	778	29.9	0.027	0.722	2.268	1497	952.7	5E-04	20.1	2.7431	159.9
	23.3	35.5	33.6	10.3	0.13	14.66	587	1.455	781	152.8	779	29.9	0.027	0.722	2.269	1497	952.7	5E-04	20.13	2.745	159.9
	23.3	35.5	33.6	10.3	0.13	14.59	587	1.452	778	151.9	775	29.7	0.027	0.721	2.265	1497	952.7	5E-04	20.05	2.7393	159.8
										152.6	777	29.8	0.027	0.722	2.267	1497	952.7	5E-04	20.09		
	23.4	39.4	36.8	13.4	0.15	16.8	587	1.452	778	154.3	776	30.1	0.027	0.721	2.265	1497	952.7	6E-04	20.05	2.7393	159.8
	23.6	39.8	37.2	13.6	0.15	16.96	587	1.451	777	153.7	775	30	0.027	0.721	2.264	1497	952.7	6E-04	20.03	2.7374	159.8
	23.6	39.8	37.2	13.6	0.15	16.96	587	1.45	776	153.7	774	30	0.027	0.72	2.263	1497	952.7	6E-04	20	2.7355	159.8
										153.9	775	30.1	0.027	0.721	2.264	1497	952.7	6E-04	20.03		
f ~ 585 Hz	21.7	30	28.6	6.9	0.11	12.51	586	1.554	887	164.1	886	32.1	0.027	0.771	2.421	1494	951.1	3E-04	22.91	2.9317	160.4
L = 73 cm	21.8	30.1	28.7	6.91	0.11	12.43	586	1.554	888	162.8	886	31.8	0.027	0.771	2.422	1494	951.1	3E-04	22.92	2.9317	160.4
PR ~ 2.9	21.9	30.2	28.8	6.9	0.11	12.52	586	1.557	891	164.2	889	32.1	0.027	0.772	2.427	1494	951.1	3E-04	23.01	2.9374	160.4
										163.7	887	32	0.027	0.771	2.423	1494	951.1	3E-04	22.95		
	22.1	34.2	32	9.92	0.14	15.25	586	1.557	892	176.9	890	34.6	0.027	0.773	2.428	1494	951.1	4E-04	23.02	2.9374	160.4
	22.3	34.6	32.4	10.1	0.14	15.39	586	1.552	887	175.4	884	34.3	0.027	0.771	2.421	1494	951.1	4E-04	22.88	2.928	160.4
	22.3	34.9	32.7	10.4	0.14	15.42	586	1.556	892	170.7	889	33.4	0.027	0.772	2.427	1494	951.1	4E-04	23	2.9355	160.4
										174.3	888	34.1	0.027	0.772	2.425	1494	951.1	4E-04	22.97		
	22.5	38.4	35.7	13.2	0.15	17.46	586	1.554	890	162.8	887	31.8	0.027	0.772	2.425	1494	951.1	5E-04	22.95	2.9317	160.4
	22.6	39.2	36.3	13.7	0.16	17.65	586	1.548	883	169.2	880	33.1	0.027	0.769	2.416	1494	951.1	5E-04	22.78	2.9204	160.4
	22.8	39.4	36.5	13.7	0.16	17.7	586	1.553	890	169.8	886	33.2	0.027	0.772	2.424	1494	951.1	5E-04	22.93	2.9299	160.4
										167.3	885	32.7	0.027	0.771	2.421	1494	951.1	5E-04	22.89		
f ~ 585 Hz	22.7	31.4	29.8	7.08	0.12	13.21	586	1.651	1005	184	1002	36	0.027	0.82	2.577	1494	951.1	2E-04	25.91	3.1147	161
L = 73 cm	22.7	31.4	29.8	7.09	0.12	13.17	586	1.651	1005	183.3	1002	35.8	0.027	0.82	2.577	1494	951.1	2E-04	25.91	3.1147	161
PR ~ 3.1	22.7	31.5	29.9	7.19	0.12	13.2	586	1.644	997	181.3	993	35.4	0.027	0.817	2.566	1494	951.1	2E-04	25.7	3.1015	160.9
										182.9	999	35.7	0.027	0.819	2.573	1494	951.1	2E-04	25.84		
	22.9	35.8	33.5	10.6	0.14	16.08	586	1.65	1005	174.6	1001	34.1	0.027	0.82	2.576	1494	951.1	3E-04	25.89	3.1129	160.9
	22.9	35.4	33.1	10.2	0.14	16.14	586	1.651	1006	182.2	1002	35.6	0.027	0.82	2.578	1494	951.1	3E-04	25.92	3.1147	161
	22.9	35.1	32.9	9.99	0.14	15.52	586	1.65	1005	178.9	1001	35	0.027	0.82	2.576	1494	951.1	3E-04	25.89	3.1129	160.9
										178.6	1001	34.9	0.027	0.82	2.577	1494	951.1	3E-04	25.9		
	23	39.2	36.3	13.3	0.16	18.08	586	1.645	999	179.5	995	35.1	0.027	0.818	2.569	1494	951.1	4E-04	25.74	3.1034	160.9
	23	39.3	36.3	13.3	0.16	18.17	586	1.648	1002	179.3	999	35	0.027	0.819	2.573	1494	951.1	4E-04	25.83	3.1091	160.9
	23.1	39.6	36.7	13.6	0.16	18.08	586	1.64	993	175.5	989	34.3	0.027	0.815	2.561	1494	951.1	4E-04	25.59	3.094	160.9
										178.1	994	34.8	0.027	0.817	2.568	1494	951.1	4E-04	25.72		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 585 Hz	0.1607	11.436	7.2708	7.2708	1.7365	15.478	0.1686	0.4545	0.002	0.4848
L = 73 cm	0.1592	11.406	7.0787	7.0787	1.7078	15.273	0.1687	0.4542	0.002	0.4845
PR ~ 2.7	0.1603	11.447	7.2779	7.2779	1.747	15.494	0.1686	0.4552	0.002	0.4854
						15.415				0.4849
	0.1419	9.7465	4.9571	4.9571	1.7122	12.128	0.1687	0.4539	0.002	0.4842
	0.1406	9.7439	4.8746	4.8746	1.7094	12.059	0.1687	0.4536	0.002	0.484
	0.1409	9.7351	4.8702	4.8702	1.6997	12.047	0.1687	0.4545	0.002	0.4848
						12.078				0.4843
	0.1305	8.5373	3.7227	3.7227	1.7261	10.178	0.1686	0.4545	0.002	0.4848
	0.1297	8.5325	3.6747	3.6747	1.7201	10.138	0.1685	0.4549	0.002	0.4851
	0.1297	8.5325	3.6747	3.6747	1.7201	10.138	0.1685	0.4552	0.002	0.4854
						10.152				0.4851
f ~ 585 Hz	0.1564	11.541	7.2493	7.2493	1.8355	15.547	0.1696	0.4247	0.002	0.4573
L = 73 cm	0.1568	11.527	7.2399	7.2399	1.8214	15.525	0.1695	0.4247	0.002	0.4573
PR ~ 2.9	0.1563	11.543	7.2504	7.2504	1.8373	15.55	0.1695	0.4239	0.002	0.4565
						15.541				0.457
	0.1409	9.319	5.0385	5.0385	1.9793	11.898	0.1693	0.4239	0.002	0.4565
	0.14	9.3043	4.9487	4.9487	1.9619	11.807	0.1692	0.4253	0.002	0.4577
	0.1392	9.2602	4.808	4.808	1.9098	11.647	0.1692	0.4242	0.002	0.4567
						11.784				0.457
	0.1289	8.6128	3.7792	3.7792	1.8212	10.299	0.1691	0.4247	0.002	0.4571
	0.129	8.1661	3.644	3.644	1.8935	9.841	0.1691	0.4264	0.002	0.4587
	0.1289	8.171	3.6461	3.6461	1.9	9.8478	0.1689	0.425	0.002	0.4573
						9.9961				0.4577
f ~ 585 Hz	0.1544	10.848	7.0581	7.0581	2.0587	14.886	0.169	0.3998	0.002	0.434
L = 73 cm	0.1545	10.841	7.0532	7.0532	2.051	14.874	0.169	0.3998	0.002	0.434
PR ~ 3.1	0.154	10.818	6.9586	6.9586	2.0281	14.765	0.169	0.4015	0.002	0.4356
						14.842				0.4345
	0.1365	9.2967	4.7147	4.7147	1.9529	11.607	0.1689	0.4	0.002	0.4342
	0.1372	9.3693	4.9036	4.9036	2.0387	11.834	0.1689	0.3998	0.002	0.434
	0.1398	9.3382	5.0075	5.0075	2.002	11.89	0.1689	0.4	0.002	0.4342
						11.777				0.4341
	0.1287	8.2521	3.7733	3.7733	2.0084	10.031	0.1688	0.4012	0.002	0.4353
	0.1284	8.2499	3.7491	3.7491	2.0055	10.011	0.1688	0.4005	0.002	0.4346
	0.1282	8.2188	3.6897	3.6897	1.9639	9.9323	0.1688	0.4024	0.002	0.4364
						9.9913				0.4354

Experiment Information	Ta (C)	Ttc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs Λ	PR %	SPL (dB)
f ~ 1200 Hz	20.7	27.9	27.5	6.8	0.06	6.51	1199	0.504	45.5	47.22	44.9	9.23	0.056	0.122	0.383	3057	1946	0.104	0.812	0.9508	150.6
L = 65 cm	20.7	28.1	27.7	6.99	0.06	6.66	1199	0.504	45.5	46.99	44.9	9.18	0.056	0.122	0.383	3057	1946	0.107	0.812	0.9508	150.6
PR ~ 0.9	20.8	28.3	27.9	7.08	0.06	6.87	1199	0.504	45.5	47.88	44.9	9.35	0.056	0.122	0.383	3057	1946	0.107	0.812	0.9508	150.6
										47.36	44.9	9.25	0.056	0.122	0.383	3057	1946	0.106	0.812		
	20.9	32.3	31.6	10.7	0.08	8.31	1200	0.506	45.8	50.98	45.2	9.96	0.056	0.122	0.384	3059	1948	0.16	0.816	0.9546	150.7
	21	33.1	32.4	11.4	0.08	8.64	1200	0.507	46	49.88	45.4	9.75	0.056	0.123	0.385	3059	1948	0.168	0.82	0.9565	150.7
	21	33.1	32.4	11.4	0.08	8.59	1200	0.506	45.8	49.57	45.2	9.69	0.056	0.122	0.385	3059	1948	0.169	0.817	0.9546	150.7
										50.14	45.2	9.8	0.056	0.122	0.385	3059	1948	0.166	0.818		
	21.3	37.4	36.5	15.2	0.09	9.99	1200	0.507	46.1	48.69	45.5	9.51	0.056	0.123	0.385	3059	1948	0.219	0.823	0.9565	150.7
	21.5	37.5	36.6	15.1	0.09	10.09	1201	0.507	46.1	49.54	45.4	9.68	0.056	0.123	0.385	3062	1949	0.216	0.821	0.9565	150.7
	21.7	37.6	36.7	15	0.09	10.15	1201	0.506	45.9	50.18	45.3	9.8	0.056	0.122	0.385	3062	1949	0.214	0.819	0.9546	150.7
										49.47	45.4	9.67	0.056	0.123	0.385	3061	1949	0.216	0.821		
f ~ 1200 Hz	21.6	30.3	29.8	8.2	0.07	7.01	1201	0.55	54.2	49.21	53.5	9.61	0.056	0.133	0.418	3062	1949	0.084	0.967	1.0376	151.4
L = 65 cm	21.6	29.7	29.3	7.68	0.06	6.79	1201	0.55	54.2	43.59	53.5	8.52	0.056	0.133	0.418	3062	1949	0.079	0.967	1.0376	151.4
PR ~ 1.0	21.6	29.3	28.9	7.3	0.06	6.6	1201	0.55	54.2	44.63	53.5	8.72	0.056	0.133	0.418	3062	1949	0.075	0.967	1.0376	151.4
										45.81	53.5	8.95	0.056	0.133	0.418	3062	1949	0.079	0.967		
	21.8	33.8	33.1	11.3	0.08	8.8	1201	0.55	54.3	51.31	53.6	10	0.056	0.133	0.418	3062	1949	0.115	0.969	1.0376	151.4
	21.8	34	33.3	11.5	0.08	8.96	1201	0.549	54.1	51.39	53.4	10	0.056	0.133	0.417	3062	1949	0.117	0.965	1.0357	151.4
	21.8	33.9	33.2	11.4	0.08	8.88	1201	0.549	54.1	51.35	53.4	10	0.056	0.133	0.417	3062	1949	0.116	0.965	1.0357	151.4
										51.36	53.5	10	0.056	0.133	0.418	3062	1949	0.116	0.966		
	21.9	37.5	36.6	14.7	0.09	10.25	1201	0.549	54.1	51.75	53.4	10.1	0.056	0.133	0.418	3062	1949	0.149	0.966	1.0357	151.4
	21.9	38.2	37.1	15.2	0.1	10.51	1202	0.549	54	56.75	53.3	11.1	0.056	0.133	0.417	3064	1951	0.156	0.962	1.0357	151.4
	22	38.4	37.3	15.3	0.1	10.6	1202	0.549	54.1	56.9	53.3	11.1	0.056	0.133	0.417	3064	1951	0.156	0.963	1.0357	151.4
										55.13	53.3	10.8	0.056	0.133	0.417	3064	1950	0.154	0.964		
f ~ 1200 Hz	22	30.4	29.9	7.88	0.07	7.04	1202	0.602	65	52.86	64.1	10.3	0.056	0.146	0.458	3064	1951	0.055	1.158	1.1357	152.2
L = 65 cm	22	30.5	30	7.99	0.07	7.09	1202	0.602	65	51.66	64.1	10.1	0.056	0.146	0.458	3064	1951	0.056	1.158	1.1357	152.2
PR ~ 1.1	22	30.3	29.8	7.8	0.07	6.99	1202	0.602	65	51.73	64.1	10.1	0.056	0.146	0.458	3064	1951	0.055	1.158	1.1357	152.2
										52.09	64.1	10.2	0.056	0.146	0.458	3064	1951	0.056	1.158		
	22	33.7	32.9	10.9	0.08	8.91	1202	0.601	64.8	55.34	63.9	10.8	0.056	0.145	0.457	3064	1951	0.078	1.154	1.1338	152.2
	22.1	34	33.2	11.1	0.08	9.03	1202	0.601	64.8	55.1	63.9	10.8	0.056	0.145	0.457	3064	1951	0.078	1.155	1.1338	152.2
	22.1	34.3	33.5	11.4	0.08	9.03	1202	0.602	65	53.84	64.1	10.5	0.056	0.146	0.458	3064	1951	0.08	1.159	1.1357	152.2
										54.76	64	10.7	0.056	0.145	0.457	3064	1951	0.079	1.156		
	22.3	39.3	38.2	15.9	0.1	10.81	1202	0.602	65.1	56.97	64.3	11.1	0.056	0.146	0.458	3064	1951	0.11	1.161	1.1357	152.2
	22.4	38.8	37.7	15.3	0.1	10.55	1202	0.602	65.1	58.74	64.3	11.5	0.056	0.146	0.458	3064	1951	0.105	1.162	1.1357	152.2
	22.5	39	37.9	15.4	0.1	10.63	1203	0.6	64.6	58.01	63.7	11.3	0.056	0.145	0.456	3067	1953	0.107	1.151	1.1319	152.2
										57.91	64.1	11.3	0.056	0.146	0.457	3065	1951	0.107	1.158		

Experiment Information	T a (C)	T tc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 1200 Hz	22.3	30.3	29.8	7.45	0.07	7.7	1203	0.948	161	59.49	159	11.6	0.056	0.229	0.72	3067	1953	0.008	2.867	1.7885	156.1
L = 65 cm	22.4	30.3	29.7	7.35	0.07	7.74	1203	0.949	162	60.63	159	11.8	0.056	0.23	0.721	3067	1953	0.008	2.876	1.7904	156.1
PR ~ 1.8	22.3	30.2	29.7	7.36	0.07	7.63	1203	0.949	162	59.71	159	11.7	0.056	0.229	0.721	3067	1953	0.008	2.873	1.7904	156.1
										59.94	159	11.7	0.056	0.229	0.721	3067	1953	0.008	2.872		
	22.4	34.2	33.3	10.9	0.09	9.75	1203	0.948	161	66.17	159	12.9	0.056	0.229	0.72	3067	1953	0.012	2.87	1.7885	156.1
	22.4	34.1	33.2	10.8	0.09	9.68	1203	0.948	161	66.26	159	12.9	0.056	0.229	0.72	3067	1953	0.012	2.87	1.7885	156.1
	22.5	34.5	33.6	11.1	0.09	9.85	1203	0.948	161	65.69	159	12.8	0.056	0.229	0.72	3067	1953	0.012	2.873	1.7885	156.1
										66.04	159	12.9	0.056	0.229	0.72	3067	1953	0.012	2.871		
	22.5	38.4	37.2	14.7	0.1	11.46	1203	0.947	161	63.97	159	12.5	0.056	0.229	0.72	3067	1953	0.017	2.866	1.7866	156.1
	22.5	38.5	37.3	14.8	0.1	11.55	1203	0.947	161	64.07	159	12.5	0.056	0.229	0.72	3067	1953	0.017	2.866	1.7866	156.1
	22.5	38.6	37.4	14.9	0.1	11.62	1203	0.947	161	64.06	159	12.5	0.056	0.229	0.72	3067	1953	0.017	2.866	1.7866	156.1
										64.03	159	12.5	0.056	0.229	0.72	3067	1953	0.017	2.866		
f ~ 1200 Hz	22.5	31.1	30.5	8.03	0.07	7.96	1203	1.004	181	57.05	178	11.1	0.056	0.243	0.763	3067	1953	0.007	3.222	1.8941	156.6
L = 65 cm	22.5	31.1	30.5	8.03	0.07	7.92	1203	1.002	180	56.74	178	11.1	0.056	0.242	0.762	3067	1953	0.007	3.209	1.8904	156.6
PR ~ 1.9	22.5	31.1	30.4	7.94	0.08	8.08	1203	1	179	66.93	177	13.1	0.056	0.242	0.76	3067	1953	0.007	3.196	1.8866	156.6
										60.24	178	11.8	0.056	0.242	0.762	3067	1953	0.007	3.209		
	22.6	34.8	33.9	11.3	0.09	10.05	1203	1.001	180	65.95	178	12.9	0.056	0.242	0.761	3067	1953	0.01	3.206	1.8885	156.6
	22.5	34.9	34	11.5	0.09	10.12	1203	1.001	180	65.29	177	12.8	0.056	0.242	0.761	3067	1953	0.01	3.203	1.8885	156.6
	22.6	35.1	34.2	11.6	0.09	10.18	1203	1.001	180	65.14	178	12.7	0.056	0.242	0.761	3067	1953	0.01	3.206	1.8885	156.6
										65.46	177	12.8	0.056	0.242	0.761	3067	1953	0.01	3.205		
	22.7	39.6	38.3	15.6	0.11	11.88	1203	1	180	69.03	177	13.5	0.056	0.242	0.76	3067	1953	0.014	3.202	1.8866	156.6
	22.7	39.7	38.4	15.7	0.11	11.92	1203	1	180	68.84	177	13.4	0.056	0.242	0.76	3067	1953	0.014	3.202	1.8866	156.6
	22.7	39.4	38.1	15.4	0.11	11.96	1203	1	180	70.44	177	13.8	0.056	0.242	0.76	3067	1953	0.014	3.202	1.8866	156.6
										69.43	177	13.6	0.056	0.242	0.76	3067	1953	0.014	3.202		
f ~ 1200 Hz	22.6	31.1	30.4	7.83	0.08	8.16	1203	1.054	199	68.52	197	13.4	0.056	0.255	0.801	3067	1953	0.006	3.554	1.9885	157.1
L = 65 cm	22.6	31.1	30.4	7.83	0.08	8.19	1203	1.05	198	68.79	195	13.4	0.056	0.254	0.798	3067	1953	0.006	3.527	1.9809	157
PR ~ 2.0	22.6	31.1	30.4	7.84	0.08	8.15	1203	1.054	199	68.43	197	13.4	0.056	0.255	0.801	3067	1953	0.006	3.554	1.9885	157.1
										68.58	196	13.4	0.056	0.255	0.8	3067	1953	0.006	3.545		
	22.6	34.8	33.9	11.3	0.09	10.09	1203	1.053	199	66.23	196	12.9	0.056	0.255	0.8	3067	1953	0.008	3.547	1.9866	157
	22.6	34.9	34	11.4	0.09	10.17	1203	1.05	198	66.21	195	12.9	0.056	0.254	0.798	3067	1953	0.008	3.527	1.9809	157
	22.6	35.1	34.2	11.6	0.09	10.24	1203	1.051	198	65.55	196	12.8	0.056	0.254	0.799	3067	1953	0.008	3.534	1.9828	157
										66	196	12.9	0.056	0.254	0.799	3067	1953	0.008	3.536		
	22.8	39.6	38.3	15.5	0.11	12.03	1203	1.048	197	70.43	195	13.8	0.056	0.254	0.797	3067	1953	0.011	3.52	1.9771	157
	22.8	39.7	38.3	15.5	0.11	12.11	1203	1.049	198	70.48	195	13.8	0.056	0.254	0.798	3067	1953	0.011	3.527	1.979	157
	22.8	39.4	38.1	15.3	0.11	11.97	1203	1.049	198	70.96	195	13.9	0.056	0.254	0.798	3067	1953	0.011	3.527	1.979	157
										70.62	195	13.8	0.056	0.254	0.797	3067	1953	0.011	3.524		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1200 Hz	0.1948	15.8	6.3609	6.3609	0.6194	18.193	0.1692	0.824	0.002	0.8412
L = 65 cm	0.197	15.826	6.607	6.607	0.6348	18.39	0.1692	0.824	0.002	0.8412
PR ~ 1.5	0.1961	15.818	6.5233	6.5233	0.6302	18.324	0.1692	0.824	0.002	0.8412
						18.302				0.8412
	0.167	12.515	4.4541	4.4541	0.7029	14.03	0.1692	0.824	0.002	0.8412
	0.1675	12.519	4.4926	4.4926	0.706	14.058	0.1692	0.824	0.002	0.8412
	0.1661	12.507	4.3786	4.3786	0.6961	13.974	0.1692	0.824	0.002	0.8412
						14.021				0.8412
	0.1511	11.296	3.3619	3.3619	0.6842	12.276	0.1691	0.824	0.002	0.8411
	0.1506	11.294	3.3406	3.3406	0.6829	12.263	0.1691	0.824	0.002	0.8411
	0.152	11.299	3.4054	3.4054	0.6867	12.303	0.1691	0.824	0.002	0.8411
						12.28				0.8411
f ~ 1200 Hz	0.1928	15.818	6.3678	6.3678	0.6299	18.213	0.1692	0.7765	0.002	0.7947
L = 65 cm	0.1929	15.831	6.45	6.45	0.638	18.283	0.1692	0.7765	0.002	0.7947
PR ~ 1.6	0.1956	15.853	6.7013	6.7013	0.6517	18.483	0.1692	0.7765	0.002	0.7947
						18.326				0.7947
	0.1666	12.529	4.496	4.496	0.7133	14.069	0.1691	0.7756	0.002	0.7938
	0.1663	12.532	4.4971	4.4971	0.7157	14.072	0.1691	0.7765	0.002	0.7947
	0.165	12.526	4.4212	4.4212	0.7109	14.019	0.1691	0.7765	0.002	0.7947
						14.053				0.7944
	0.1495	11.3	3.3216	3.3216	0.6876	12.258	0.1691	0.7765	0.002	0.7947
	0.149	11.298	3.3007	3.3007	0.6863	12.245	0.1691	0.7765	0.002	0.7947
	0.1502	11.304	3.3644	3.3644	0.6915	12.285	0.1691	0.7756	0.002	0.7938
						12.263				0.7944
f ~ 1200 Hz	0.1933	15.843	6.5336	6.5336	0.6455	18.353	0.1691	0.7309	0.002	0.7502
L = 65 cm	0.1933	15.843	6.5336	6.5336	0.6455	18.353	0.1692	0.7293	0.002	0.7486
PR ~ 1.7	0.1943	15.85	6.617	6.617	0.6494	18.419	0.1692	0.7293	0.002	0.7486
						18.375				0.7492
	0.1663	12.541	4.5383	4.5383	0.723	14.108	0.1691	0.7333	0.002	0.7526
	0.1652	12.533	4.4603	4.4603	0.7165	14.05	0.1691	0.7333	0.002	0.7526
	0.1657	12.538	4.4993	4.4993	0.7205	14.08	0.1691	0.7341	0.002	0.7534
						14.079				0.7528
	0.1489	11.311	3.3456	3.3456	0.6975	12.282	0.1691	0.7358	0.002	0.755
	0.1498	11.315	3.3889	3.3889	0.7009	12.309	0.1691	0.7358	0.002	0.755
	0.1489	11.312	3.3458	3.3458	0.6981	12.283	0.1691	0.735	0.002	0.7542
						12.291				0.7547

Experiment Information	T a (C)	T tc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 1200 Hz	22.4	30.8	30.3	7.86	0.07	7.56	1203	0.801	115	55.36	113	10.8	0.056	0.194	0.609	3067	1953	0.017	2.049	1.5111	154.7
L = 65 cm	22.4	30.5	30	7.57	0.07	7.46	1203	0.801	115	56.74	113	11.1	0.056	0.194	0.609	3067	1953	0.017	2.049	1.5111	154.7
PR ~ 1.5	22.4	30.6	30.1	7.66	0.07	7.5	1203	0.801	115	56.32	113	11	0.056	0.194	0.609	3067	1953	0.017	2.049	1.5111	154.7
										56.14	113	11	0.056	0.194	0.609	3067	1953	0.017	2.049		
	22.4	34.5	33.6	11.2	0.09	9.53	1203	0.801	115	62.83	113	12.3	0.056	0.194	0.609	3067	1953	0.025	2.049	1.5111	154.7
	22.4	34.4	33.5	11.1	0.09	9.49	1203	0.801	115	63.11	113	12.3	0.056	0.194	0.609	3067	1953	0.025	2.049	1.5111	154.7
	22.4	34.7	33.8	11.4	0.09	9.6	1203	0.801	115	62.22	113	12.2	0.056	0.194	0.609	3067	1953	0.025	2.049	1.5111	154.7
										62.72	113	12.3	0.056	0.194	0.609	3067	1953	0.025	2.049		
	22.5	38.5	37.4	14.9	0.1	11.06	1203	0.801	115	61.15	114	11.9	0.056	0.194	0.609	3067	1953	0.033	2.051	1.5111	154.7
	22.5	38.6	37.5	15	0.1	11.11	1203	0.801	115	61.04	114	11.9	0.056	0.194	0.609	3067	1953	0.033	2.051	1.5111	154.7
	22.5	38.3	37.2	14.7	0.1	10.96	1203	0.801	115	61.38	114	12	0.056	0.194	0.609	3067	1953	0.032	2.051	1.5111	154.7
										61.19	114	12	0.056	0.194	0.609	3067	1953	0.033	2.051		
f ~ 1200 Hz	22.4	30.8	30.3	7.85	0.07	7.68	1203	0.85	130	56.3	128	11	0.056	0.206	0.646	3067	1953	0.014	2.307	1.6036	155.2
L = 65 cm	22.4	30.7	30.2	7.75	0.07	7.68	1203	0.85	130	57.03	128	11.1	0.056	0.206	0.646	3067	1953	0.013	2.307	1.6036	155.2
PR ~ 1.6	22.4	30.4	29.9	7.46	0.07	7.55	1203	0.85	130	58.25	128	11.4	0.056	0.206	0.646	3067	1953	0.013	2.307	1.6036	155.2
										57.19	128	11.2	0.056	0.206	0.646	3067	1953	0.013	2.307		
	22.5	34.5	33.6	11.1	0.09	9.58	1203	0.851	130	63.75	128	12.5	0.056	0.206	0.647	3067	1953	0.019	2.315	1.6055	155.2
	22.5	34.5	33.6	11.1	0.09	9.61	1203	0.85	130	63.97	128	12.5	0.056	0.206	0.646	3067	1953	0.019	2.309	1.6036	155.2
	22.5	34.7	33.8	11.3	0.09	9.71	1203	0.85	130	63.54	128	12.4	0.056	0.206	0.646	3067	1953	0.02	2.309	1.6036	155.2
										63.75	128	12.5	0.056	0.206	0.646	3067	1953	0.019	2.311		
	22.6	38.8	37.7	15.1	0.1	11.25	1203	0.85	130	61.45	128	12	0.056	0.206	0.646	3067	1953	0.026	2.311	1.6036	155.2
	22.6	38.9	37.7	15.1	0.1	11.3	1203	0.85	130	61.34	128	12	0.056	0.206	0.646	3067	1953	0.026	2.311	1.6036	155.2
	22.6	38.6	37.5	14.9	0.1	11.17	1203	0.851	130	61.81	128	12.1	0.056	0.206	0.647	3067	1953	0.025	2.317	1.6055	155.2
										61.53	128	12	0.056	0.206	0.646	3067	1953	0.026	2.313		
f ~ 1200 Hz	22.5	30.7	30.2	7.65	0.07	7.67	1203	0.903	146	57.69	144	11.3	0.056	0.218	0.686	3067	1953	0.01	2.606	1.7036	155.7
L = 65 cm	22.4	30.6	30.1	7.65	0.07	7.67	1203	0.905	147	57.69	145	11.3	0.056	0.219	0.688	3067	1953	0.01	2.615	1.7074	155.7
PR ~ 1.7	22.4	30.5	30	7.56	0.07	7.62	1203	0.905	147	58.05	145	11.3	0.056	0.219	0.688	3067	1953	0.01	2.615	1.7074	155.7
										57.81	145	11.3	0.056	0.219	0.687	3067	1953	0.01	2.612		
	22.5	34.4	33.5	11	0.09	9.62	1203	0.9	145	64.62	143	12.6	0.056	0.218	0.684	3067	1953	0.015	2.589	1.6979	155.7
	22.5	34.6	33.7	11.2	0.09	9.7	1203	0.9	145	64.04	143	12.5	0.056	0.218	0.684	3067	1953	0.015	2.589	1.6979	155.7
	22.5	34.5	33.6	11.1	0.09	9.67	1203	0.899	145	64.4	143	12.6	0.056	0.217	0.683	3067	1953	0.015	2.583	1.696	155.7
										64.35	143	12.6	0.056	0.218	0.684	3067	1953	0.015	2.587		
	22.6	38.7	37.5	14.9	0.1	11.33	1203	0.897	144	62.34	143	12.2	0.056	0.217	0.682	3067	1953	0.021	2.574	1.6923	155.7
	22.6	38.5	37.4	14.8	0.1	11.24	1203	0.897	144	62.64	143	12.2	0.056	0.217	0.682	3067	1953	0.02	2.574	1.6923	155.7
	22.6	38.7	37.5	14.9	0.1	11.34	1203	0.898	145	62.4	143	12.2	0.056	0.217	0.683	3067	1953	0.021	2.58	1.6941	155.7
										62.46	143	12.2	0.056	0.217	0.682	3067	1953	0.021	2.576		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1200 Hz	0.1971	15.491	6.1921	6.1921	0.587	17.805	0.1692	1.0092	0.002	1.0233
L = 65 cm	0.198	15.451	6.2669	6.2669	0.59	17.823	0.1692	1.0092	0.002	1.0233
PR ~ 1.2	0.1933	14.834	6.6083	6.6083	0.6367	17.545	0.1692	1.0092	0.002	1.0233
						17.724				1.0233
	0.165	13.524	4.3747	4.3747	0.6085	14.885	0.1692	1.0092	0.002	1.0233
	0.1673	12.359	4.2601	4.2601	0.6639	13.766	0.1691	1.0092	0.002	1.0232
	0.1674	12.392	4.2242	4.2242	0.6582	13.773	0.1691	1.0076	0.002	1.0217
						14.142				1.0227
	0.1524	11.356	3.1868	3.1868	0.6386	12.236	0.169	1.0061	0.002	1.0202
	0.1509	11.188	3.23	3.23	0.6532	12.103	0.1689	1.0061	0.002	1.0202
	0.1502	11.103	3.2517	3.2517	0.6593	12.037	0.1689	1.0061	0.002	1.0202
						12.125				1.0202
f ~ 1200 Hz	0.1986	15.797	6.5148	6.5148	0.6176	18.299	0.1696	0.9375	0.002	0.9527
L = 65 cm	0.1995	15.79	6.5118	6.5118	0.6131	18.291	0.1696	0.9375	0.002	0.9527
PR ~ 1.3	0.1962	15.789	6.3563	6.3563	0.6124	18.18	0.1696	0.9375	0.002	0.9527
						18.257				0.9527
	0.1675	12.484	4.3354	4.3354	0.6785	13.926	0.1695	0.9362	0.002	0.9514
	0.1679	12.473	4.2968	4.2968	0.6696	13.891	0.1695	0.9362	0.002	0.9514
	0.168	12.48	4.334	4.334	0.6754	13.921	0.1695	0.9388	0.002	0.954
						13.913				0.9523
	0.1521	11.262	3.2701	3.2701	0.6553	12.193	0.1693	0.9388	0.002	0.954
	0.1512	11.26	3.23	3.23	0.6532	12.17	0.1692	0.9375	0.002	0.9527
	0.1508	11.252	3.1895	3.1895	0.6467	12.141	0.1692	0.9348	0.002	0.95
						12.168				0.9522
f ~ 1200 Hz	0.1963	15.971	6.4381	6.4381	0.6203	18.395	0.1692	0.8812	0.002	0.8973
L = 65 cm	0.1973	15.872	6.5191	6.5191	0.6239	18.367	0.1692	0.88	0.002	0.8961
PR ~ 1.4	0.1955	15.76	6.2782	6.2782	0.6073	18.1	0.1693	0.88	0.002	0.8961
						18.287				0.8965
	0.1667	12.492	4.3381	4.3381	0.6846	13.935	0.1693	0.8788	0.002	0.895
	0.166	12.36	4.3029	4.3029	0.6833	13.795	0.1693	0.8788	0.002	0.895
	0.1671	12.637	4.2991	4.2991	0.6749	14.041	0.1692	0.8788	0.002	0.895
						13.924				0.895
	0.1508	11.28	3.2523	3.2523	0.6613	12.2	0.1692	0.88	0.002	0.8961
	0.1525	11.516	3.3807	3.3807	0.6774	12.488	0.1691	0.88	0.002	0.8961
	0.1508	11.178	3.2954	3.2954	0.6706	12.13	0.1691	0.88	0.002	0.8961
						12.273				0.8961

Experiment Information	T a (C)	T to (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 1200 Hz	22.4	31	30.5	8.07	0.07	7.24	1203	0.654	76.7	52.47	75.6	10.3	0.056	0.158	0.497	3067	1953	0.04	1.366	1.2338	152.9
L = 65 cm	22.4	30.9	30.4	7.98	0.07	7.17	1203	0.654	76.7	52.74	75.6	10.3	0.056	0.158	0.497	3067	1953	0.04	1.366	1.2338	152.9
PR ~ 1.2	22.4	30.5	30	7.57	0.07	7.01	1203	0.654	76.7	56.9	75.6	11.1	0.056	0.158	0.497	3067	1953	0.038	1.366	1.2338	152.9
										54.04	75.6	10.6	0.056	0.158	0.497	3067	1953	0.039	1.366		
	22.4	34.6	33.8	11.4	0.08	9.21	1203	0.654	76.7	54.39	75.6	10.6	0.056	0.158	0.497	3067	1953	0.057	1.366	1.2338	152.9
	22.5	35.1	34.2	11.7	0.09	9.33	1203	0.654	76.8	59.34	75.7	11.6	0.056	0.158	0.497	3067	1953	0.058	1.367	1.2338	152.9
	22.5	35.2	34.3	11.8	0.09	9.36	1203	0.655	77	58.83	75.9	11.5	0.056	0.158	0.498	3067	1953	0.058	1.371	1.2357	152.9
										57.52	75.8	11.2	0.056	0.158	0.497	3067	1953	0.058	1.368		
	22.7	39.5	38.4	15.7	0.1	11	1203	0.656	77.3	57.07	76.3	11.2	0.056	0.159	0.499	3067	1953	0.075	1.378	1.2376	152.9
	22.8	39.4	38.3	15.5	0.1	10.92	1203	0.656	77.3	58.38	76.4	11.4	0.056	0.159	0.499	3067	1953	0.074	1.379	1.2376	152.9
	22.8	39.3	38.2	15.4	0.1	10.86	1203	0.656	77.3	58.93	76.4	11.5	0.056	0.159	0.499	3067	1953	0.074	1.379	1.2376	152.9
										58.13	76.4	11.4	0.056	0.159	0.499	3067	1953	0.074	1.379		
f ~ 1200 Hz	21.6	29.8	29.3	7.67	0.07	7.36	1202	0.704	88.8	55.2	87.3	10.8	0.056	0.17	0.535	3064	1951	0.03	1.577	1.3282	153.6
L = 65 cm	21.6	29.8	29.3	7.68	0.07	7.31	1202	0.704	88.8	54.8	87.3	10.7	0.056	0.17	0.535	3064	1951	0.03	1.577	1.3282	153.6
PR ~ 1.3	21.7	30.1	29.6	7.87	0.07	7.48	1202	0.704	88.8	54.73	87.4	10.7	0.056	0.17	0.535	3064	1951	0.03	1.579	1.3282	153.6
										54.91	87.4	10.7	0.056	0.17	0.535	3064	1951	0.03	1.578		
	21.9	34.3	33.4	11.5	0.09	9.45	1203	0.705	89	60.64	87.5	11.8	0.056	0.17	0.535	3067	1953	0.044	1.58	1.33	153.6
	21.9	34.4	33.5	11.6	0.09	9.41	1203	0.705	89	59.85	87.5	11.7	0.056	0.17	0.535	3067	1953	0.044	1.58	1.33	153.6
	21.9	34.3	33.4	11.5	0.09	9.41	1203	0.703	88.5	60.36	87	11.8	0.056	0.17	0.534	3067	1953	0.044	1.571	1.3263	153.5
										60.28	87.3	11.8	0.056	0.17	0.535	3067	1953	0.044	1.577		
	22.2	38.6	37.5	15.3	0.1	10.89	1203	0.703	88.6	58.57	87.2	11.4	0.056	0.17	0.534	3067	1953	0.058	1.575	1.3263	153.5
	22.3	38.9	37.8	15.5	0.1	10.99	1203	0.704	88.9	58.38	87.6	11.4	0.056	0.17	0.535	3067	1953	0.058	1.581	1.3282	153.6
	22.3	39.1	38	15.7	0.1	11.02	1203	0.706	89.4	57.8	88.1	11.3	0.056	0.171	0.536	3067	1953	0.058	1.59	1.3319	153.6
										58.25	87.6	11.4	0.056	0.17	0.535	3067	1953	0.058	1.582		
f ~ 1200 Hz	22.3	30.6	30.1	7.77	0.07	7.48	1203	0.749	101	55.44	99.1	10.8	0.056	0.181	0.569	3067	1953	0.023	1.79	1.413	154.1
L = 65 cm	22.3	30.5	30	7.67	0.07	7.43	1203	0.75	101	55.76	99.4	10.9	0.056	0.181	0.57	3067	1953	0.022	1.795	1.4149	154.1
PR ~ 1.4	22.2	30.7	30.2	7.96	0.07	7.51	1203	0.75	101	54.28	99.3	10.6	0.056	0.181	0.57	3067	1953	0.023	1.793	1.4149	154.1
										55.16	99.3	10.8	0.056	0.181	0.57	3067	1953	0.023	1.792		
	22.2	34.6	33.7	11.5	0.09	9.53	1203	0.751	101	61.19	99.6	12	0.056	0.182	0.57	3067	1953	0.033	1.798	1.4168	154.1
	22.2	34.7	33.8	11.6	0.09	9.59	1203	0.751	101	61.08	99.6	11.9	0.056	0.182	0.57	3067	1953	0.034	1.798	1.4168	154.1
	22.3	34.8	33.9	11.6	0.09	9.48	1203	0.751	101	60.32	99.7	11.8	0.056	0.182	0.571	3067	1953	0.033	1.799	1.4168	154.1
										60.86	99.6	11.9	0.056	0.182	0.57	3067	1953	0.033	1.798		
	22.4	38.9	37.8	15.4	0.1	11.05	1203	0.75	101	59.1	99.5	11.5	0.056	0.181	0.57	3067	1953	0.044	1.796	1.4149	154.1
	22.5	38.4	37.3	14.8	0.1	10.89	1203	0.75	101	60.55	99.6	11.8	0.056	0.181	0.57	3067	1953	0.042	1.798	1.4149	154.1
	22.5	38.8	37.7	15.2	0.1	11.06	1203	0.75	101	59.94	99.6	11.7	0.056	0.181	0.57	3067	1953	0.043	1.798	1.4149	154.1
										59.86	99.5	11.7	0.056	0.181	0.57	3067	1953	0.043	1.797		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1200 Hz	0.2155	18.172	7.351	7.351	0.5283	20.943	0.1702	1.3095	0.002	1.3205
L = 65 cm	0.2118	18.167	7.1504	7.1504	0.5257	20.799	0.1702	1.3095	0.002	1.3205
PR ~ 0.9	0.2072	18.185	7.0623	7.0623	0.5356	20.756	0.1701	1.3095	0.002	1.3205
						20.833				1.3205
	0.1811	13.822	4.6632	4.6632	0.5704	15.326	0.17	1.3043	0.002	1.3154
	0.176	13.804	4.3877	4.3877	0.558	15.146	0.17	1.3018	0.002	1.3128
	0.1766	13.799	4.3862	4.3862	0.5546	15.14	0.17	1.3043	0.002	1.3154
						15.204				1.3145
	0.1592	12.312	3.2931	3.2931	0.5448	13.176	0.1698	1.3018	0.002	1.3128
	0.1583	12.324	3.3169	3.3169	0.5542	13.199	0.1697	1.3018	0.002	1.3128
	0.1578	12.333	3.3403	3.3403	0.5614	13.22	0.1696	1.3043	0.002	1.3153
						13.198				1.3136
f ~ 1200 Hz	0.2044	15.688	6.0977	6.0977	0.5506	17.911	0.1696	1.2	0.002	1.2119
L = 65 cm	0.2079	18.094	6.5064	6.5064	0.4877	20.307	0.1696	1.2	0.002	1.2119
PR ~ 1.0	0.2127	18.116	6.8528	6.8528	0.4993	20.553	0.1696	1.2	0.002	1.2119
						19.59				1.2119
	0.174	13.827	4.4317	4.4317	0.5741	15.193	0.1695	1.2	0.002	1.2119
	0.1719	13.828	4.3595	4.3595	0.575	15.152	0.1695	1.2022	0.002	1.2141
	0.173	13.828	4.3953	4.3953	0.5745	15.172	0.1695	1.2022	0.002	1.2141
						15.172				1.2134
	0.157	12.356	3.4107	3.4107	0.5789	13.278	0.1695	1.2022	0.002	1.2141
	0.1554	11.239	3.2833	3.2833	0.6349	12.178	0.1695	1.2022	0.002	1.2141
	0.1545	11.241	3.2638	3.2638	0.6366	12.169	0.1694	1.2022	0.002	1.2141
						12.541				1.2141
f ~ 1200 Hz	0.199	15.755	6.3425	6.3425	0.5914	18.14	0.1694	1.0963	0.002	1.1094
L = 65 cm	0.201	15.733	6.2591	6.2591	0.578	18.062	0.1694	1.0963	0.002	1.1094
PR ~ 1.1	0.2049	15.734	6.4104	6.4104	0.5788	18.169	0.1694	1.0963	0.002	1.1094
						18.124				1.1094
	0.1677	13.892	4.5667	4.5667	0.6191	15.333	0.1694	1.0982	0.002	1.1112
	0.1662	13.888	4.4887	4.4887	0.6165	15.283	0.1693	1.0982	0.002	1.1112
	0.1654	13.868	4.3719	4.3719	0.6024	15.196	0.1693	1.0963	0.002	1.1093
						15.271				1.1106
	0.1499	11.241	3.1489	3.1489	0.6373	12.109	0.1692	1.0963	0.002	1.1093
	0.1501	11.265	3.2708	3.2708	0.6572	12.196	0.1692	1.0963	0.002	1.1093
	0.1512	11.255	3.2482	3.2482	0.6491	12.175	0.1691	1.1	0.002	1.1129
						12.16				1.1105

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1200 Hz	0.1931	15.876	6.7109	6.7109	0.6656	18.51	0.1692	0.6962	0.002	0.7165
L = 65 cm	0.1927	15.897	6.8048	6.8048	0.6784	18.596	0.1692	0.6955	0.002	0.7158
PR ~ 1.8	0.1945	15.88	6.7976	6.7976	0.668	18.576	0.1692	0.6955	0.002	0.7158
						18.561				0.716
	0.1651	12.563	4.5848	4.5848	0.7403	14.158	0.1692	0.6962	0.002	0.7165
	0.1659	12.565	4.6245	4.6245	0.7413	14.185	0.1692	0.6962	0.002	0.7165
	0.1639	12.557	4.506	4.506	0.735	14.101	0.1691	0.6962	0.002	0.7165
						14.148				0.7165
	0.1481	11.333	3.394	3.394	0.7157	12.329	0.1691	0.6969	0.002	0.7172
	0.1474	11.334	3.3732	3.3732	0.7169	12.319	0.1691	0.6969	0.002	0.7172
	0.1469	11.334	3.3522	3.3522	0.7167	12.307	0.1691	0.6969	0.002	0.7172
						12.318				0.7172
f ~ 1200 Hz	0.188	15.831	6.2251	6.2251	0.6382	18.127	0.1691	0.6574	0.002	0.6788
L = 65 cm	0.1887	15.826	6.2229	6.2229	0.6348	18.12	0.1691	0.6587	0.002	0.6801
PR ~ 1.9	0.1882	14.079	6.2964	6.2964	0.7489	16.676	0.1691	0.66	0.002	0.6813
						17.641				0.6801
	0.1617	12.56	4.4334	4.4334	0.7378	14.059	0.1691	0.6593	0.002	0.6807
	0.1609	12.551	4.3586	4.3586	0.7304	14.003	0.1691	0.6593	0.002	0.6807
	0.1602	12.549	4.323	4.323	0.7288	13.979	0.1691	0.6593	0.002	0.6807
						14.013				0.6807
	0.1457	10.412	3.2117	3.2117	0.7723	11.386	0.169	0.66	0.002	0.6813
	0.1453	10.409	3.1922	3.1922	0.7701	11.373	0.169	0.66	0.002	0.6813
	0.1453	10.428	3.2554	3.2554	0.788	11.428	0.169	0.66	0.002	0.6813
						11.396				0.6813
f ~ 1200 Hz	0.1872	14.104	6.382	6.382	0.7666	16.763	0.1691	0.6262	0.002	0.6486
L = 65 cm	0.1868	14.109	6.384	6.384	0.7696	16.769	0.1691	0.6286	0.002	0.6509
PR ~ 2.0	0.1873	14.103	6.3813	6.3813	0.7656	16.762	0.1691	0.6262	0.002	0.6486
						16.765				0.6494
	0.1614	12.564	4.4349	4.4349	0.741	14.063	0.1691	0.6268	0.002	0.6492
	0.1605	12.564	4.3987	4.3987	0.7408	14.04	0.1691	0.6286	0.002	0.6509
	0.1597	12.555	4.3251	4.3251	0.7334	13.986	0.1691	0.628	0.002	0.6503
						14.03				0.6501
	0.1447	10.428	3.236	3.236	0.7879	11.416	0.1689	0.6298	0.002	0.652
	0.1442	10.429	3.2171	3.2171	0.7885	11.406	0.1689	0.6292	0.002	0.6515
	0.1453	10.435	3.277	3.277	0.7939	11.446	0.1689	0.6292	0.002	0.6515
						11.423				0.6517

Experiment Information	Ta (C)	T to (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 1200 Hz	22.1	30.3	29.6	7.53	0.08	8.2	1203	1.104	218	71.63	215	14	0.056	0.267	0.838	3067	1953	0.005	3.881	2.0828	157.5
L = 65 cm	22.2	30.5	29.8	7.62	0.08	8.3	1203	1.103	218	71.63	215	14	0.056	0.267	0.838	3067	1953	0.005	3.878	2.0809	157.5
PR ~ 2.1	22.2	30.7	30	7.82	0.08	8.34	1203	1.104	219	70.16	215	13.7	0.056	0.267	0.839	3067	1953	0.005	3.885	2.0828	157.5
										71.14	215	13.9	0.056	0.267	0.838	3067	1953	0.005	3.881		
	22.2	34.3	33.4	11.2	0.09	10.11	1203	1.104	219	66.97	215	13.1	0.056	0.267	0.839	3067	1953	0.007	3.885	2.0828	157.5
	22.3	34.3	33.4	11.1	0.09	10.11	1203	1.105	219	67.57	216	13.2	0.056	0.267	0.84	3067	1953	0.007	3.896	2.0847	157.5
	22.3	34.6	33.7	11.4	0.09	10.25	1203	1.101	217	66.78	214	13	0.056	0.266	0.836	3067	1953	0.007	3.867	2.0771	157.4
										67.11	215	13.1	0.056	0.267	0.838	3067	1953	0.007	3.883		
	22.6	39.1	37.8	15.2	0.11	12	1203	1.103	218	71.63	216	14	0.056	0.267	0.838	3067	1953	0.009	3.892	2.0809	157.5
	22.6	39.1	37.7	15.1	0.11	12.04	1203	1.104	219	71.89	216	14	0.056	0.267	0.839	3067	1953	0.009	3.899	2.0828	157.5
	22.6	38.9	37.6	15	0.11	11.91	1204	1.103	218	71.99	215	14.1	0.056	0.267	0.838	3070	1954	0.009	3.876	2.0809	157.5
										71.83	215	14	0.056	0.267	0.838	3068	1953	0.009	3.889		
f ~ 1200 Hz	22.4	30.4	29.7	7.34	0.08	8.12	1204	1.155	239	72.8	235	14.2	0.056	0.279	0.877	3070	1954	0.004	4.242	2.179	157.9
L = 65 cm	22.4	30.5	29.8	7.44	0.08	8.12	1204	1.154	239	71.82	235	14	0.056	0.279	0.876	3070	1954	0.004	4.235	2.1771	157.8
PR ~ 2.2	22.4	30.6	29.9	7.53	0.08	8.25	1204	1.154	239	72.1	235	14.1	0.056	0.279	0.876	3070	1954	0.004	4.235	2.1771	157.8
										72.24	235	14.1	0.056	0.279	0.876	3070	1954	0.004	4.237		
	22.5	34.3	33.4	10.9	0.09	10.14	1203	1.156	240	69.04	237	13.5	0.056	0.28	0.879	3067	1953	0.005	4.271	2.1809	157.9
	22.6	34.5	33.6	11	0.09	10.25	1203	1.154	239	69.22	236	13.5	0.056	0.279	0.877	3067	1953	0.006	4.26	2.1771	157.8
	22.6	34.7	33.7	11.1	0.09	10.36	1203	1.155	240	68.77	236	13.4	0.056	0.279	0.878	3067	1953	0.006	4.268	2.179	157.9
										69.01	236	13.5	0.056	0.279	[illegible]	3067	1953	0.006	4.266		
	22.7	38.6	37.2	14.5	0.11	12.12	1203	1.157	240	75.39	237	14.7	0.056	0.28	0.88	3067	1953	0.007	4.286	2.1828	157.9
	22.8	38.9	37.5	14.7	0.11	12.26	1203	1.158	241	75.31	238	14.7	0.056	0.28	0.881	3067	1953	0.007	4.298	2.1847	157.9
	22.8	38.9	37.5	14.7	0.11	12.21	1203	1.159	241	74.97	238	14.6	0.056	0.281	0.881	3067	1953	0.007	4.305	2.1865	157.9
										75.23	238	14.7	0.056	0.28	0.88	3067	1953	0.007	4.296		
f ~ 725	20.9	27.7	27.3	6.41	0.06	6.43	725	0.506	75.8	49.52	75.1	9.67	0.034	0.203	0.636	1848	1177	0.035	1.747	0.9546	150.7
L = 60 cm	20.9	28.4	28	7.09	0.06	6.74	725	0.507	76.1	46.92	75.4	9.17	0.034	0.203	0.638	1848	1177	0.038	1.754	0.9565	150.7
PR ~ 0.9	20.9	28.3	27.9	6.99	0.06	6.67	725	0.506	75.8	47.07	75.1	9.2	0.034	0.203	0.636	1848	1177	0.038	1.747	0.9546	150.7
										47.83	75.2	9.35	0.034	0.203	0.637	1848	1177	0.037	1.75		
	21.3	33.3	32.6	11.3	0.08	8.64	725	0.506	75.9	50.32	75.3	9.83	0.034	0.203	0.637	1848	1177	0.059	1.751	0.9546	150.7
	21.3	33.6	32.9	11.6	0.08	8.86	725	0.506	75.9	50.34	75.3	9.84	0.034	0.203	0.637	1848	1177	0.061	1.751	0.9546	150.7
	21.3	33.9	33.2	11.9	0.08	9.11	725	0.506	75.9	50.54	75.3	9.88	0.034	0.203	0.637	1848	1177	0.062	1.751	0.9546	150.7
										50.4	75.3	9.85	0.034	0.203	0.637	1848	1177	0.061	1.751		
	21.4	36.9	36	14.6	0.09	10.08	726	0.507	76.2	51.18	75.4	10	0.034	0.203	0.637	1851	1178	0.076	1.752	0.9565	150.7
	21.5	37.3	36.4	14.9	0.09	10.22	726	0.507	76.2	50.89	75.4	9.94	0.034	0.203	0.637	1851	1178	0.077	1.753	0.9565	150.7
	21.6	37.6	36.7	15.1	0.09	10.32	726	0.508	75.9	50.74	75.2	9.91	0.034	0.203	0.636	1851	1178	0.078	1.747	0.9546	150.7
										50.94	75.3	9.95	0.034	0.203	0.637	1851	1178	0.077	1.751		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 1200 Hz	0.1872	14.154	6.639	6.639	0.8013	17.005	0.1693	0.5978	0.002	0.6214
L = 65 cm	0.1856	14.154	6.559	6.559	0.8013	16.943	0.1693	0.5984	0.002	0.6219
PR ~ 2.1	0.1847	14.131	6.394	6.394	0.785	16.796	0.1693	0.5978	0.002	0.6213
						16.914				0.6215
	0.1613	12.575	4.4753	4.4753	0.7493	14.099	0.1693	0.5978	0.002	0.6213
	0.1614	12.584	4.5157	4.5157	0.756	14.133	0.1692	0.5973	0.002	0.6208
	0.1598	12.572	4.4016	4.4016	0.7471	14.05	0.1692	0.5995	0.002	0.6229
						14.094				0.6217
	0.1452	10.442	3.2994	3.2994	0.8013	11.466	0.1691	0.5984	0.002	0.6218
	0.1449	10.446	3.3003	3.3003	0.8043	11.47	0.1691	0.5978	0.002	0.6213
	0.1459	10.447	3.3412	3.3412	0.8054	11.495	0.1691	0.5984	0.002	0.6218
						11.477				0.6216
f ~ 1200 Hz	0.1888	14.173	6.814	6.814	0.8145	17.159	0.1692	0.5714	0.002	0.5959
L = 65 cm	0.1886	14.157	6.7224	6.7224	0.8035	17.073	0.1692	0.5719	0.002	0.5964
PR ~ 2.2	0.1865	14.162	6.6426	6.6426	0.8067	17.015	0.1692	0.5719	0.002	0.5964
						17.082				0.5963
	0.1613	12.605	4.5999	4.5999	0.7724	14.206	0.1691	0.5709	0.002	0.5955
	0.1602	12.607	4.5622	4.5622	0.7744	14.184	0.1691	0.5719	0.002	0.5964
	0.159	12.601	4.4845	4.4845	0.7694	14.129	0.1691	0.5714	0.002	0.5959
						14.173				0.5959
	0.1449	10.487	3.4386	3.4386	0.8435	11.592	0.169	0.5704	0.002	0.595
	0.1438	10.486	3.3955	3.3955	0.8426	11.565	0.1689	0.5699	0.002	0.5945
	0.1442	10.482	3.3942	3.3942	0.8388	11.56	0.1689	0.5695	0.002	0.594
						11.572				0.5945
f ~ 725	0.2181	18.22	7.8043	7.8043	0.554	21.311	0.17	1.3043	0.002	1.3154
L = 60 cm	0.2099	18.165	7.0544	7.0544	0.5249	20.732	0.17	1.3018	0.002	1.3128
PR ~ 0.9	0.2116	18.168	7.151	7.151	0.5266	20.801	0.17	1.3043	0.002	1.3154
						20.948				1.3145
	0.1761	13.811	4.4266	4.4266	0.563	15.175	0.1698	1.3043	0.002	1.3154
	0.173	13.811	4.3187	4.3187	0.5632	15.113	0.1698	1.3043	0.002	1.3154
	0.1698	13.815	4.2169	4.2169	0.5655	15.058	0.1698	1.3043	0.002	1.3154
						15.115				1.3154
	0.1587	12.348	3.4305	3.4305	0.5726	13.28	0.1698	1.3018	0.002	1.3128
	0.1572	12.344	3.3642	3.3642	0.5694	13.242	0.1697	1.3018	0.002	1.3128
	0.1561	12.341	3.3216	3.3216	0.5677	13.218	0.1696	1.3043	0.002	1.3153
						13.247				1.3136

Experiment Information	Ta (C)	Tc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs Λ	PR %	SPL (dB)
f ~ 725	21.4	29.8	29.1	7.69	0.07	7.1	726	0.554	90.9	53.12	90	10.4	0.034	0.222	0.696	1851	1178	0.028	2.092	1.0452	151.5
L = 60 cm	21.5	30	29.5	7.97	0.07	7.37	726	0.554	91	53.2	90.1	10.4	0.034	0.222	0.696	1851	1178	0.029	2.093	1.0452	151.5
PR ~ 1.0	21.4	29.8	29.3	7.88	0.07	7.27	726	0.554	90.9	53.1	90	10.4	0.034	0.222	0.696	1851	1178	0.029	2.092	1.0452	151.5
										53.14	90	10.4	0.034	0.222	0.696	1851	1178	0.029	2.092		
	21.5	33.7	33	11.5	0.08	9.05	726	0.555	91.3	51.94	90.4	10.1	0.034	0.222	0.698	1851	1178	0.041	2.101	1.0471	151.5
	21.5	33.8	33.1	11.6	0.08	9.11	726	0.556	91.6	51.86	90.7	10.1	0.034	0.222	0.699	1851	1178	0.042	2.108	1.0489	151.5
	21.6	33.9	33.2	11.6	0.08	9.14	726	0.556	91.7	52.04	90.8	10.2	0.034	0.223	0.699	1851	1178	0.041	2.11	1.0489	151.5
										51.94	90.6	10.1	0.034	0.222	0.699	1851	1178	0.041	2.106		
	21.6	37.9	36.8	15.2	0.1	10.69	726	0.555	91.3	57.79	90.4	11.3	0.034	0.222	0.698	1851	1178	0.055	2.102	1.0471	151.5
	21.6	38	36.9	15.3	0.1	10.74	726	0.556	91.7	57.7	90.8	11.3	0.034	0.223	0.699	1851	1178	0.055	2.11	1.0489	151.5
	21.7	38.1	37	15.3	0.1	10.89	726	0.551	90.1	58.57	89.2	11.4	0.034	0.221	0.693	1851	1178	0.056	2.073	1.0395	151.4
										58.02	90.1	11.3	0.034	0.222	0.697	1851	1178	0.055	2.095		
f ~ 725	21.4	29.8	29.3	7.88	0.07	7.35	726	0.603	108	53.72	107	10.5	0.034	0.241	0.758	1851	1178	0.021	2.478	1.1376	152.2
L = 60 cm	21.4	30	29.5	8.07	0.07	7.39	726	0.603	108	52.69	107	10.3	0.034	0.241	0.758	1851	1178	0.021	2.478	1.1376	152.2
PR ~ 1.1	21.4	30	29.5	8.07	0.07	7.43	726	0.603	108	53	107	10.4	0.034	0.241	0.758	1851	1178	0.021	2.478	1.1376	152.2
										53.14	107	10.4	0.034	0.241	0.758	1851	1178	0.021	2.478		
	21.4	33.7	33	11.6	0.08	9.12	726	0.603	108	51.92	107	10.1	0.034	0.241	0.758	1851	1178	0.03	2.478	1.1376	152.2
	21.5	33.6	32.9	11.4	0.08	9.06	726	0.603	108	52.46	107	10.2	0.034	0.241	0.758	1851	1178	0.03	2.48	1.1376	152.2
	21.5	33.3	32.6	11.1	0.08	8.95	726	0.603	108	53.19	107	10.4	0.034	0.241	0.758	1851	1178	0.029	2.48	1.1376	152.2
										52.52	107	10.3	0.034	0.241	0.758	1851	1178	0.029	2.479		
	21.6	38.1	37	15.4	0.1	10.85	726	0.603	108	57.96	107	11.3	0.034	0.241	0.758	1851	1178	0.04	2.481	1.1376	152.2
	21.6	38.1	37	15.4	0.1	10.89	726	0.603	108	58.19	107	11.4	0.034	0.241	0.758	1851	1178	0.04	2.481	1.1376	152.2
	21.6	37.9	36.8	15.2	0.1	10.82	726	0.603	108	58.55	107	11.4	0.034	0.241	0.758	1851	1178	0.039	2.481	1.1376	152.2
										58.23	107	11.4	0.034	0.241	0.758	1851	1178	0.04	2.481		
f ~ 725	21.5	29.8	29.3	7.77	0.07	7.43	726	0.654	127	55.04	126	10.8	0.034	0.262	0.822	1851	1178	0.015	2.917	1.2338	152.9
L = 60 cm	21.5	30	29.5	7.96	0.07	7.56	726	0.654	127	54.66	126	10.7	0.034	0.262	0.822	1851	1178	0.015	2.917	1.2338	152.9
PR ~ 1.2	21.5	29.8	29.3	7.77	0.07	7.42	726	0.654	127	54.96	126	10.7	0.034	0.262	0.822	1851	1178	0.015	2.917	1.2338	152.9
										54.89	126	10.7	0.034	0.262	0.822	1851	1178	0.015	2.917		
	21.5	33.7	32.8	11.3	0.09	9.31	726	0.654	127	60.73	126	11.9	0.034	0.262	0.822	1851	1178	0.021	2.917	1.2338	152.9
	21.6	34	33.1	11.5	0.09	9.4	726	0.654	127	60.3	126	11.8	0.034	0.262	0.822	1851	1178	0.022	2.919	1.2338	152.9
	21.6	34	33.1	11.5	0.09	9.4	726	0.654	127	60.3	126	11.8	0.034	0.262	0.822	1851	1178	0.022	2.919	1.2338	152.9
										60.44	126	11.8	0.034	0.262	0.822	1851	1178	0.021	2.918		
	21.6	37.9	36.8	15.2	0.1	10.92	726	0.654	127	59.13	126	11.6	0.034	0.262	0.822	1851	1178	0.028	2.919	1.2338	152.9
	21.6	37.9	36.8	15.2	0.1	10.87	726	0.654	127	58.84	126	11.5	0.034	0.262	0.822	1851	1178	0.028	2.919	1.2338	152.9
	21.6	37.7	36.6	15	0.1	10.8	726	0.654	127	59.21	126	11.6	0.034	0.262	0.822	1851	1178	0.028	2.919	1.2338	152.9
										59.06	126	11.5	0.034	0.262	0.822	1851	1178	0.028	2.919		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 725	0.2034	15.759	6.4991	6.4991	0.5943	18.255	0.1698	1.1913	0.002	1.2034
L = 60 cm	0.1979	15.761	6.2703	6.2703	0.5952	18.095	0.1697	1.1913	0.002	1.2034
PR ~ 1.0	0.1999	15.759	6.3442	6.3442	0.5941	18.145	0.1698	1.1913	0.002	1.2034
						18.165				1.2034
	0.1708	13.837	4.3622	4.3622	0.5811	15.162	0.1697	1.1892	0.002	1.2012
	0.17	13.836	4.3264	4.3264	0.5802	15.14	0.1697	1.1871	0.002	1.1991
	0.1697	13.839	4.3273	4.3273	0.5822	15.143	0.1696	1.1871	0.002	1.1991
						15.149				1.1998
	0.1538	11.252	3.2872	3.2872	0.6466	12.193	0.1696	1.1892	0.002	1.2012
	0.1533	11.251	3.2669	3.2669	0.6456	12.181	0.1696	1.1871	0.002	1.1991
	0.1521	11.262	3.2701	3.2701	0.6553	12.193	0.1696	1.1978	0.002	1.2098
						12.189				1.2034
f ~ 725	0.1984	15.77	6.3488	6.3488	0.601	18.158	0.1698	1.0945	0.002	1.1076
L = 60 cm	0.1974	15.752	6.1937	6.1937	0.5895	18.034	0.1698	1.0945	0.002	1.1076
PR ~ 1.1	0.1967	15.757	6.1959	6.1959	0.5929	18.04	0.1698	1.0945	0.002	1.1076
						18.077				1.1076
	0.1699	13.837	4.3267	4.3267	0.5808	15.141	0.1698	1.0945	0.002	1.1076
	0.1708	13.845	4.401	4.401	0.5869	15.192	0.1697	1.0945	0.002	1.1076
	0.1724	13.857	4.5167	4.5167	0.595	15.271	0.1697	1.0945	0.002	1.1076
						15.202				1.1076
	0.1524	11.254	3.248	3.248	0.6484	12.174	0.1696	1.0945	0.002	1.1076
	0.1521	11.257	3.2489	3.2489	0.651	12.177	0.1696	1.0945	0.002	1.1076
	0.1528	11.262	3.2901	3.2901	0.655	12.204	0.1696	1.0945	0.002	1.1076
						12.185				1.1076
f ~ 725	0.1972	15.795	6.4351	6.4351	0.6158	18.24	0.1697	1.0092	0.002	1.0233
L = 60 cm	0.1946	15.788	6.281	6.281	0.6116	18.126	0.1697	1.0092	0.002	1.0233
PR ~ 1.2	0.1974	15.793	6.4346	6.4346	0.6149	18.239	0.1697	1.0092	0.002	1.0233
						18.202				1.0233
	0.1693	12.485	4.4069	4.4069	0.6794	13.972	0.1697	1.0092	0.002	1.0233
	0.1681	12.479	4.3337	4.3337	0.6746	13.92	0.1696	1.0092	0.002	1.0233
	0.1681	12.479	4.3337	4.3337	0.6746	13.92	0.1696	1.0092	0.002	1.0233
						13.937				1.0233
	0.152	11.27	3.2923	3.2923	0.6615	12.212	0.1696	1.0092	0.002	1.0233
	0.1524	11.266	3.2912	3.2912	0.6583	12.208	0.1696	1.0092	0.002	1.0233
	0.1531	11.271	3.3335	3.3335	0.6624	12.236	0.1696	1.0092	0.002	1.0233
						12.219				1.0233

Experiment Information	Ta (C)	Ttc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 725	21.5	29.4	28.9	7.38	0.07	7.35	726	0.704	147	57.36	145	11.2	0.034	0.282	0.885	1851	1178	0.01	3.38	1.3282	153.6
L = 60 cm	21.5	29.2	28.7	7.18	0.07	7.24	726	0.703	146	58.01	145	11.3	0.034	0.281	0.884	1851	1178	0.01	3.371	1.3263	153.5
PR ~ 1.3	21.5	29.6	29.1	7.56	0.07	7.58	726	0.703	146	57.72	145	11.3	0.034	0.281	0.884	1851	1178	0.011	3.371	1.3263	153.5
										57.7	145	11.3	0.034	0.281	0.884	1851	1178	0.01	3.374		
	21.5	33.4	32.5	11	0.09	9.41	726	0.704	147	63.1	145	12.3	0.034	0.282	0.885	1851	1178	0.015	3.38	1.3282	153.6
	21.5	33.9	33	11.5	0.09	9.61	726	0.704	147	61.75	145	12.1	0.034	0.282	0.885	1851	1178	0.016	3.38	1.3282	153.6
	21.6	33.8	32.9	11.3	0.09	9.51	726	0.704	147	62.13	146	12.1	0.034	0.282	0.885	1851	1178	0.016	3.382	1.3282	153.6
										62.33	145	12.2	0.034	0.282	0.885	1851	1178	0.016	3.381		
	21.7	37.4	36.3	14.6	0.1	10.8	726	0.704	147	60.83	146	11.9	0.034	0.282	0.885	1851	1178	0.02	3.384	1.3282	153.6
	21.7	37.2	36.1	14.4	0.1	10.7	726	0.704	147	61.06	146	11.9	0.034	0.282	0.885	1851	1178	0.02	3.384	1.3282	153.6
	21.7	37.8	36.7	15	0.1	11	726	0.704	147	60.39	146	11.8	0.034	0.282	0.885	1851	1178	0.021	3.384	1.3282	153.6
										60.76	146	11.9	0.034	0.282	0.885	1851	1178	0.02	3.384		
f ~ 725	21.7	29.6	29.1	7.36	0.07	7.56	726	0.754	169	59.12	167	11.6	0.034	0.302	0.948	1851	1178	0.008	3.882	1.4225	154.1
L = 60 cm	21.7	29.8	29.3	7.55	0.07	7.67	726	0.754	169	58.46	167	11.4	0.034	0.302	0.948	1851	1178	0.008	3.882	1.4225	154.1
PR ~ 1.4	21.8	30.1	29.5	7.75	0.07	7.73	726	0.753	168	57.42	167	11.2	0.034	0.301	0.947	1851	1178	0.008	3.874	1.4206	154.1
										58.33	167	11.4	0.034	0.302	0.948	1851	1178	0.008	3.88		
	22	34.2	33.3	11.3	0.09	9.69	726	0.753	168	63.4	167	12.4	0.034	0.302	0.947	1851	1178	0.012	3.879	1.4206	154.1
	22.1	34.4	33.5	11.4	0.09	9.8	726	0.753	168	63.62	167	12.4	0.034	0.302	0.948	1851	1178	0.012	3.881	1.4206	154.1
	22.1	34.5	33.6	11.5	0.09	9.84	726	0.753	168	63.34	167	12.4	0.034	0.302	0.948	1851	1178	0.012	3.881	1.4206	154.1
										63.45	167	12.4	0.034	0.302	0.948	1851	1178	0.012	3.88		
	22.3	37.8	36.7	14.4	0.1	11.07	726	0.753	169	63.34	167	12.4	0.034	0.302	0.948	1851	1178	0.015	3.886	1.4206	154.1
	22.3	38.1	37	14.7	0.1	11.26	726	0.753	169	63.19	167	12.3	0.034	0.302	0.948	1851	1178	0.015	3.886	1.4206	154.1
	22.2	38.2	37	14.8	0.1	11.3	726	0.753	168	62.58	167	12.2	0.034	0.302	0.948	1851	1178	0.015	3.883	1.4206	154.1
										63.04	167	12.3	0.034	0.302	0.948	1851	1178	0.015	3.885		
f ~ 725	22.2	30.2	29.6	7.44	0.07	7.8	727	0.804	192	60.32	190	11.8	0.034	0.322	1.011	1853	1180	0.006	4.409	1.5168	154.7
L = 60 cm	22.2	30.3	29.7	7.54	0.07	7.83	727	0.804	192	59.76	190	11.7	0.034	0.322	1.011	1853	1180	0.006	4.409	1.5168	154.7
PR ~ 1.5	22.2	30.2	29.6	7.45	0.07	7.72	727	0.803	191	59.65	189	11.7	0.034	0.321	1.009	1853	1180	0.006	4.398	1.5149	154.7
										59.91	190	11.7	0.034	0.322	1.01	1853	1180	0.006	4.405		
	22.3	34.3	33.4	11.1	0.09	9.8	727	0.803	191	65.33	189	12.8	0.034	0.321	1.01	1853	1180	0.009	4.401	1.5149	154.7
	22.3	34.4	33.5	11.2	0.09	9.89	727	0.803	191	65.39	189	12.8	0.034	0.321	1.01	1853	1180	0.009	4.401	1.5149	154.7
	22.4	34.2	33.3	10.9	0.09	9.71	727	0.803	191	65.87	190	12.9	0.034	0.321	1.01	1853	1180	0.009	4.403	1.5149	154.7
										65.53	189	12.8	0.034	0.321	1.01	1853	1180	0.009	4.401		
	22.5	37.8	36.6	14.1	0.1	11.3	727	0.803	192	65.68	190	12.8	0.034	0.321	1.01	1853	1180	0.011	4.406	1.5149	154.7
	22.6	38.2	37	14.4	0.1	11.42	727	0.803	192	65.04	190	12.7	0.034	0.322	1.01	1853	1180	0.011	4.409	1.5149	154.7
	22.6	38.9	37.6	15	0.11	11.75	727	0.803	192	70.94	190	13.9	0.034	0.322	1.01	1853	1180	0.012	4.409	1.5149	154.7
										67.22	190	13.1	0.034	0.321	1.01	1853	1180	0.011	4.408		

Experiment Information	V uncert	I uncert	Ta uncert	To uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 725	0.1993	15.837	6.7792	6.7792	0.6418	18.525	0.1697	0.9375	0.002	0.9527
L = 60 cm	0.2017	15.849	6.9605	6.9605	0.6491	18.67	0.1697	0.9388	0.002	0.954
PR ~ 1.3	0.1949	15.844	6.6145	6.6145	0.6458	18.411	0.1697	0.9388	0.002	0.954
						18.535				0.9536
	0.1685	12.519	4.5303	4.5303	0.706	14.082	0.1697	0.9375	0.002	0.9527
	0.1659	12.5	4.3409	4.3409	0.6908	13.944	0.1697	0.9375	0.002	0.9527
	0.1671	12.505	4.414	4.414	0.6951	13.995	0.1696	0.9375	0.002	0.9527
						14.007				0.9527
	0.1533	11.292	3.4249	3.4249	0.6806	12.307	0.1696	0.9375	0.002	0.9527
	0.1543	11.295	3.47	3.47	0.6832	12.335	0.1696	0.9375	0.002	0.9527
	0.1515	11.286	3.3381	3.3381	0.6756	12.253	0.1696	0.9375	0.002	0.9527
						12.298				0.9527
f ~ 725	0.1956	15.869	6.793	6.793	0.6615	18.563	0.1696	0.8753	0.002	0.8916
L = 60 cm	0.1934	15.857	6.6201	6.6201	0.654	18.427	0.1696	0.8753	0.002	0.8916
PR ~ 1.4	0.1921	15.838	6.4529	6.4529	0.6425	18.292	0.1695	0.8765	0.002	0.8927
						18.427				0.892
	0.1652	12.524	4.4205	4.4205	0.7093	14.016	0.1694	0.8765	0.002	0.8927
	0.164	12.527	4.3856	4.3856	0.7117	13.997	0.1693	0.8765	0.002	0.8927
	0.1635	12.523	4.3489	4.3489	0.7086	13.97	0.1693	0.8765	0.002	0.8927
						13.995				0.8927
	0.1514	11.324	3.4791	3.4791	0.7086	12.368	0.1692	0.8765	0.002	0.8927
	0.1497	11.323	3.4125	3.4125	0.707	12.329	0.1692	0.8765	0.002	0.8927
	0.1492	11.315	3.3674	3.3674	0.7002	12.297	0.1693	0.8765	0.002	0.8927
						12.331				0.8927
f ~ 725	0.1915	15.891	6.7173	6.7173	0.6749	18.528	0.1693	0.8209	0.002	0.8382
L = 60 cm	0.1909	15.881	6.6302	6.6302	0.6687	18.456	0.1693	0.8209	0.002	0.8382
PR ~ 1.5	0.1928	15.879	6.7122	6.7122	0.6674	18.513	0.1693	0.8219	0.002	0.8392
						18.499				0.8385
	0.1644	12.552	4.5041	4.5041	0.731	14.095	0.1692	0.8219	0.002	0.8392
	0.1634	12.552	4.4672	4.4672	0.7316	14.073	0.1692	0.8219	0.002	0.8392
	0.1655	12.559	4.5833	4.5833	0.737	14.153	0.1692	0.8219	0.002	0.8392
						14.107				0.8392
	0.1498	11.355	3.534	3.534	0.7348	12.429	0.1691	0.8219	0.002	0.8391
	0.1487	11.347	3.4635	3.4635	0.7277	12.381	0.1691	0.8219	0.002	0.8391
	0.147	10.434	3.3372	3.3372	0.7937	11.48	0.1691	0.8219	0.002	0.8391
						12.097				0.8391

Experiment Information	Ta (C)	Ttc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mid V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 725	22.5	30.4	29.8	7.34	0.07	7.91	727	0.85	215	62.07	213	12.1	0.034	0.34	1.069	1853	1180	0.005	4.937	1.6036	155.2
L = 60 cm	22.5	30.5	29.9	7.43	0.07	7.98	727	0.85	215	61.82	213	12.1	0.034	0.34	1.069	1853	1180	0.005	4.937	1.6036	155.2
PR ~ 1.6	22.5	30.3	29.7	7.24	0.07	7.84	727	0.85	215	62.33	213	12.2	0.034	0.34	1.069	1853	1180	0.005	4.937	1.6036	155.2
										62.07	213	12.1	0.034	0.34	1.069	1853	1180	0.005	4.937		
	22.5	34.7	33.8	11.3	0.09	10.22	727	0.85	215	67.16	213	13.1	0.034	0.34	1.069	1853	1180	0.007	4.937	1.6036	155.2
	22.5	34.6	33.7	11.2	0.09	10.13	727	0.85	215	67.11	213	13.1	0.034	0.34	1.069	1853	1180	0.007	4.937	1.6036	155.2
	22.5	34.9	34	11.5	0.09	10.3	727	0.85	215	66.54	213	13	0.034	0.34	1.069	1853	1180	0.007	4.937	1.6036	155.2
										66.94	213	13.1	0.034	0.34	1.069	1853	1180	0.007	4.937		
	22.7	38.6	37.3	14.6	0.11	11.86	727	0.85	215	73.63	213	14.4	0.034	0.34	1.069	1853	1180	0.009	4.943	1.6036	155.2
	22.7	38.9	37.6	14.9	0.11	11.95	727	0.85	215	72.74	213	14.2	0.034	0.34	1.069	1853	1180	0.009	4.943	1.6036	155.2
	22.8	38.8	37.5	14.7	0.11	11.93	727	0.85	215	73.6	213	14.4	0.034	0.34	1.07	1853	1180	0.009	4.946	1.6036	155.2
										73.32	213	14.3	0.034	0.34	1.069	1853	1180	0.009	4.944		
f ~ 725	22.9	30.5	29.9	7.03	0.07	7.96	728	0.901	241	65.16	239	12.7	0.034	0.36	1.132	1856	1182	0.003	5.537	1.6998	155.7
L = 60 cm	22.9	30.7	30	7.13	0.08	8.2	728	0.901	241	75.64	239	14.8	0.034	0.36	1.132	1856	1182	0.003	5.537	1.6998	155.7
PR ~ 1.7	22.9	30.6	29.9	7.03	0.08	8.17	728	0.901	241	76.41	239	14.9	0.034	0.36	1.132	1856	1182	0.003	5.537	1.6998	155.7
										72.4	239	14.1	0.034	0.36	1.132	1856	1182	0.003	5.537		
	23	34.6	33.7	10.7	0.09	10.23	728	0.901	241	71.01	239	13.9	0.034	0.36	1.132	1856	1182	0.005	5.54	1.6998	155.7
	23	34.7	33.8	10.8	0.09	10.31	728	0.901	241	70.95	239	13.9	0.034	0.36	1.132	1856	1182	0.005	5.54	1.6998	155.7
	23.1	34.9	34	10.9	0.09	10.35	728	0.901	241	70.59	239	13.8	0.034	0.361	1.133	1856	1182	0.005	5.544	1.6998	155.7
										70.85	239	13.8	0.034	0.361	1.133	1856	1182	0.005	5.541		
	23.1	38.9	37.5	14.4	0.11	12.14	728	0.901	241	76.05	239	14.9	0.034	0.361	1.133	1856	1182	0.007	5.544	1.6998	155.7
	23.2	39.2	37.8	14.6	0.11	12.26	728	0.901	241	75.82	239	14.8	0.034	0.361	1.133	1856	1182	0.007	5.547	1.6998	155.7
	23.2	39.4	38	14.8	0.11	12.34	728	0.901	241	75.34	239	14.7	0.034	0.361	1.133	1856	1182	0.007	5.547	1.6998	155.7
										75.74	239	14.8	0.034	0.361	1.133	1856	1182	0.007	5.546		
f ~ 725	23.2	30.8	30.1	6.92	0.08	8.3	728	0.954	271	78.87	268	15.4	0.034	0.382	1.2	1856	1182	0.003	6.219	1.7998	156.2
L = 60 cm	23.2	31	30.3	7.11	0.08	8.44	728	0.954	271	78.07	268	15.3	0.034	0.382	1.2	1856	1182	0.003	6.219	1.7998	156.2
PR ~ 1.8	23.1	31	30.3	7.21	0.08	8.5	728	0.954	270	77.59	268	15.2	0.034	0.382	1.199	1856	1182	0.003	6.215	1.7998	156.2
										78.18	268	15.3	0.034	0.382	1.199	1856	1182	0.003	6.217		
	23.3	35.2	34.1	10.8	0.1	10.64	728	0.953	270	80.9	268	15.8	0.034	0.381	1.198	1856	1182	0.004	6.209	1.7979	156.2
	23.3	35.4	34.3	11	0.1	10.73	728	0.952	270	80.17	267	15.7	0.034	0.381	1.197	1856	1182	0.004	6.196	1.796	156.2
	23.4	35.7	34.6	11.2	0.1	10.85	728	0.952	270	79.7	267	15.6	0.034	0.381	1.197	1856	1182	0.004	6.2	1.796	156.2
										80.26	267	15.7	0.034	0.381	1.198	1856	1182	0.004	6.202		
	23.4	39.2	37.8	14.4	0.11	12.44	728	0.952	270	78.11	267	15.3	0.034	0.381	1.197	1856	1182	0.005	6.2	1.796	156.2
	23.5	39.6	38.2	14.7	0.11	12.61	728	0.952	270	77.67	267	15.2	0.034	0.381	1.198	1856	1182	0.006	6.204	1.796	156.2
	23.6	39.5	38.1	14.5	0.11	12.56	728	0.952	270	78.4	267	15.3	0.034	0.381	1.198	1856	1182	0.005	6.208	1.796	156.2
										78.06	267	15.3	0.034	0.381	1.198	1856	1182	0.006	6.204		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 725	0.19	15.923	6.8161	6.8161	0.6944	18.628	0.1691	0.7765	0.002	0.7947
L = 60 cm	0.1887	15.919	6.7289	6.7289	0.6916	18.56	0.1691	0.7765	0.002	0.7947
PR ~ 1.6	0.1913	15.928	6.9055	6.9055	0.6973	18.698	0.1691	0.7765	0.002	0.7947
						18.628				0.7947
	0.1602	12.578	4.4396	4.4396	0.7514	14.079	0.1691	0.7765	0.002	0.7947
	0.1611	12.577	4.476	4.476	0.7509	14.101	0.1691	0.7765	0.002	0.7947
	0.1592	12.569	4.3649	4.3649	0.7445	14.024	0.1691	0.7765	0.002	0.7947
						14.068				0.7947
	0.1466	10.466	3.4317	3.4317	0.8238	11.567	0.169	0.7765	0.002	0.7947
	0.1457	10.456	3.3647	3.3647	0.8138	11.517	0.169	0.7765	0.002	0.7947
	0.146	10.466	3.4101	3.4101	0.8234	11.554	0.1689	0.7765	0.002	0.7946
						11.546				0.7946
f ~ 725	0.1898	15.98	7.1103	7.1103	0.729	18.896	0.1689	0.7325	0.002	0.7517
L = 60 cm	0.1881	14.219	7.0113	7.0113	0.8463	17.357	0.1689	0.7325	0.002	0.7517
PR ~ 1.7	0.1887	14.231	7.1086	7.1086	0.8549	17.446	0.1689	0.7325	0.002	0.7517
						17.899				0.7517
	0.1608	12.633	4.6898	4.6898	0.7945	14.291	0.1688	0.7325	0.002	0.7517
	0.1599	12.632	4.6494	4.6494	0.7938	14.264	0.1688	0.7325	0.002	0.7517
	0.1594	12.627	4.6081	4.6081	0.7898	14.233	0.1688	0.7325	0.002	0.7517
						14.263				0.7517
	0.1449	10.495	3.4629	3.4629	0.8509	11.614	0.1688	0.7325	0.002	0.7517
	0.1439	10.492	3.4187	3.4187	0.8483	11.585	0.1687	0.7325	0.002	0.7517
	0.1433	10.487	3.3747	3.3747	0.8429	11.553	0.1687	0.7325	0.002	0.7517
						11.584				0.7517
f ~ 725	0.1871	14.271	7.2222	7.2222	0.8824	17.573	0.1687	0.6918	0.002	0.7121
L = 60 cm	0.1848	14.258	7.0306	7.0306	0.8735	17.406	0.1687	0.6918	0.002	0.7121
PR ~ 1.8	0.1838	14.25	6.9379	6.9379	0.8681	17.324	0.1688	0.6918	0.002	0.7121
						17.434				0.7121
	0.1584	11.553	4.623	4.623	0.9051	13.306	0.1687	0.6925	0.002	0.7128
	0.1574	11.543	4.5429	4.5429	0.8969	13.242	0.1687	0.6933	0.002	0.7135
	0.1562	11.537	4.4667	4.4667	0.8917	13.185	0.1686	0.6933	0.002	0.7135
						13.244				0.7133
	0.143	10.52	3.471	3.471	0.8739	11.642	0.1686	0.6933	0.002	0.7135
	0.1418	10.514	3.4046	3.4046	0.8689	11.598	0.1685	0.6933	0.002	0.7135
	0.1422	10.523	3.4503	3.4503	0.8771	11.633	0.1685	0.6933	0.002	0.7135
						11.624				0.7135

Experiment Information	T a (C)	T tc (C)	Ts (C)	Ts-Ta (C)	Cur (A)	Volt (V)	Freq (Hz)	mic V (mV)	Rs	h W/m^2K	Corr Rs	Nu	X	ε	KC (πε)	Λ*Λ	β (2ΛΛ/π)	Gr Rs*Rs	Rs/Λ	PR %	SPL (dB)
f ~ 725	23.4	31.1	30.4	6.99	0.08	8.68	729	1.003	299	81.66	295	16	0.034	0.401	1.26	1859	1183	0.002	6.853	1.8922	156.6
L = 60 cm	23.5	31.5	30.8	7.28	0.08	8.8	729	1.003	299	79.49	296	15.5	0.034	0.401	1.26	1859	1183	0.002	6.857	1.8922	156.6
PR ~ 1.9	23.4	31.6	30.9	7.47	0.08	8.91	729	1.003	299	78.43	295	15.3	0.034	0.401	1.26	1859	1183	0.002	6.853	1.8922	156.6
										79.86	295	15.6	0.034	0.401	1.26	1859	1183	0.002	6.854		
	23.5	35.6	34.5	11	0.1	10.94	729	1.003	299	81.89	296	16	0.034	0.401	1.26	1859	1183	0.003	6.857	1.8922	156.6
	23.7	35.7	34.6	10.9	0.1	11.1	729	1.003	299	83.98	296	16.4	0.034	0.401	1.26	1859	1183	0.003	6.866	1.8922	156.6
	23.7	36	34.9	11.2	0.1	11.23	729	1.004	300	82.78	297	16.2	0.034	0.402	1.262	1859	1183	0.003	6.879	1.8941	156.6
										82.89	296	16.2	0.034	0.401	1.261	1859	1183	0.003	6.867		
	23.7	39.3	37.9	14.2	0.11	12.67	729	1.004	300	80.83	297	15.8	0.034	0.402	1.262	1859	1183	0.004	6.879	1.8941	156.6
	23.8	39.7	38.3	14.5	0.11	12.8	729	1.004	300	80.04	297	15.6	0.034	0.402	1.262	1859	1183	0.004	6.883	1.8941	156.6
	24	40	38.4	14.4	0.12	13	729	1.004	300	89.02	297	17.4	0.034	0.402	1.262	1859	1183	0.004	6.892	1.8941	156.6
										83.3	297	16.3	0.034	0.402	1.262	1859	1183	0.004	6.885		

Experiment Information	V uncert	I uncert	Ta uncert	Tc uncert	Req uncert	overall Nusselt uncert	Ta uncert	Mic V uncert	f uncert	overall Rs uncert
f ~ 725	0.1819	14.316	7.1509	7.1509	0.9137	17.552	0.1686	0.658	0.002	0.6793
L = 60 cm	0.1798	14.281	6.8659	6.8659	0.8894	17.293	0.1685	0.658	0.002	0.6793
PR ~ 1.9	0.178	14.264	6.6904	6.6904	0.8775	17.14	0.1686	0.658	0.002	0.6793
						17.329				0.6793
	0.1558	11.566	4.5517	4.5517	0.9162	13.269	0.1685	0.658	0.002	0.6793
	0.1547	11.593	4.6005	4.6005	0.9396	13.328	0.1684	0.658	0.002	0.6792
	0.1533	11.578	4.4822	4.4822	0.9262	13.233	0.1684	0.6574	0.002	0.6786
						13.277				0.679
	0.1418	10.552	3.5263	3.5263	0.9043	11.707	0.1684	0.6574	0.002	0.6786
	0.1408	10.543	3.4567	3.4567	0.8955	11.656	0.1684	0.6574	0.002	0.6786
	0.1409	9.8081	3.4699	3.4699	0.996	11.013	0.1683	0.6574	0.002	0.6786
						11.459				0.6786

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